RELOCATED ROOTS:

a community-focused urban agriculture facility

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urban agriculture facility

A Design Thesis Submitted to the Department of Architecture and Landscape Architecture of the North Dakota State University, Fargo, ND.

In Partial Fulfillment of the Requirements for the Degree of Master of Architecture

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THESIS ABSTRACT

WINDY CITY HARVEST | FIGURE 1

ABSTRACT

The design of 407 New Street seeks to introduce the agricultural sector into the urban environment. By integrating agriculture into the city context, the project aims to introduce a new typological identity to the neighborhood and revitalize the community.

This thesis project, titled “Relocated Roots,” addresses a limitation in current thinking about agriculture within the urban environment. It aims to expand the public knowledge by providing an educated architectural experience that both informs the user of modern growing techniques and positively promotes the message of sustainable city farming.

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INTRODUCTION

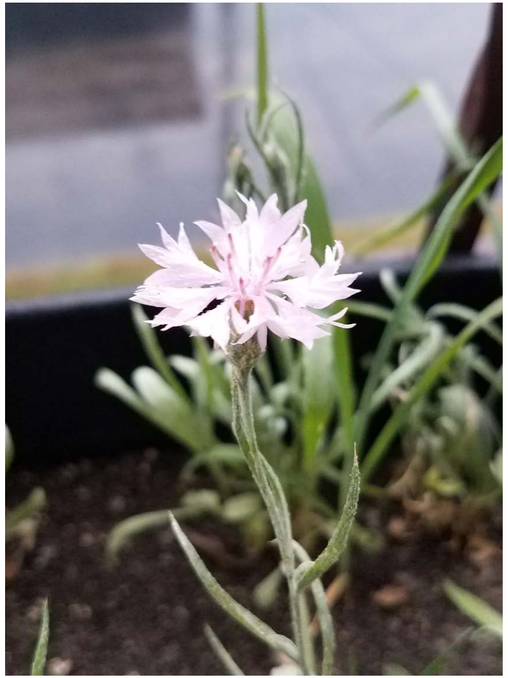
BACKGROUND

Oakes, North Dakota is a small farm town in the middle of nowhere. It is home to about 2,000 people, with only one working stoplight and two gas stations. I grew up in large metropolitan cities all over the continental United States, but it wasn't until my family landed in Oakes that I finally had a place I considered "home."

It was also in this little farm town that my mom and I shared a hobby for the first time. In the far left corner of our backyard, we laid out space for a small garden. It wasn't big or fancy as we didn't know much about gardening. But at the very least, we knew the basics: water, dirt, seeds and sun. We found an old shovel in the shed and that's all we needed to begin.

After weeks of watering and waiting, watering and waiting, we finally saw our plantings take shape. By the end of the summer we had grown a small harvest of herbs and green beans. We did this for a couple of years and we never got better or grew enough to any significance, but I'll never forget the feeling of satisfaction that we could do it.

In nostalgia of those times and in anticipation for this thesis, I attempted to do the same this last summer. Armed with several dishpans, a power drill and four bags of dirt, I planted a small variety of flowers and herbs. Here in the middle of North Fargo, on a third story balcony of a building by a bowling alley, I was able to grow plants in the city.

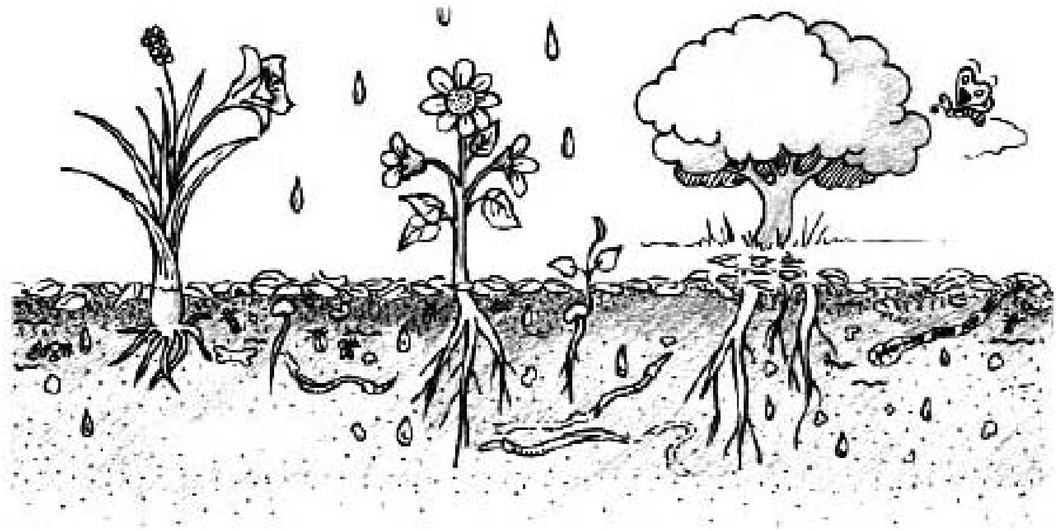


BALCONY GROWN BACHELOR BUTTON | FIGURE 2

The thesis concept revolves around this very idea. Can we as an increasingly urbanizing society successfully cultivate plants in the urban environment? And if so, how can architecture facilitate and guide that transition? What methods have proven architecture can promote and advocate social change with its design?

How can architecture promote and advocate for social change, while facilitating the integration of agriculture into the urban environment?

NARRATIVE



CITY SEEDLINGS | FIGURE 3

The way people are living is changing. People are increasingly relocating from rural areas to attractive and exciting urban communities. I myself moved away from my rural hometown to an urban city six years ago and will likely never live someplace that remote again. In 2015, The United Nations reported that 54% of the world's population resides in urban areas. That percentage is expected to grow to 66% by 2050 (2014). This influx leads to a limited amount of available space in cities with fewer green and open areas. This decrease in natural environments is a limitation surrounding our current mindset and consequently, city design for immense population growth can lead to a disconnection from the natural environment.

By implementing strategies to facilitate agriculture in the urban environment, we can provide a consistent supply of fresh produce while also providing healthy spaces for people to gather and socialize. This can be achieved by investigating how to increase crop yield while decreasing the farming footprint. Researching and implementing modern technologies like multi-story greenhouses, aquaponic/aeroponic/hydroponic systems, water management, waste-to-resource systems will also increase city farming's effectiveness. By growing taller and more efficiently, we can reduce the amount of space required for growing while yielding more food. As a profession dedicated to the public's health, safety, and welfare, Architects have a unique ability to plan and create spaces that influence the greater good. Our discipline can facilitate city farming by innovating our food source growth within our building designs. This idea of promoting social change, in conjunction with goals to revive our communities and heal our pollinators is a daunting but necessary task.

Although it is a relatively recent form of farming, urban agriculture is a modern phenomenon that is already happening. In order to address its integration into the urban environment, several strategies will need to be studied in order to provide accurate considerations in the design process: typological precedents, field research of existing conditions, and simulations of building performance. These strategies will lead the design to a comprehensive final solution that accomplishes the goals of the project.

Relocated Roots is focused on facilitating the integration of agriculture within the urban environment. It aims to redesign an underdeveloped site into a futuristic farming facility that incorporates principles of sustainable design, modern farm technology, as well as strengthens the sense of community. **This thesis is intended to demonstrate that architecture is a vehicle by which social change can travel and become instilled in society.**

OPPORTUNITIES

01. There's a longing for people living in densely developed cities to reconnect to farming and to nature.

Consistent contact with nature leads to many cognitive benefits. A study by psychologists from Carleton University have found a relationship between life satisfaction, improved moods and pro-environmental attitudes and their "subjective nature connectedness (Capaldi et al 2014)."

Another study by Kellert and Wilson suggests humans have spent all of our evolutionary history in nature, and have only relatively recently began to urbanize. This innate inclination to connect to nature is embedded in our modern psychology (1993). People's inherent desire to be close to the natural environment is an integral part of the thesis project. Integrating agriculture into the urban environment would have to be designed in such a way that commercial production wouldn't be obstructed by providing space for socialization.

02. Due to the urbanization of the US, growing more nutritious food closer to the city is necessary to support the increasing populations.

There's a growing demand for locally grown produce. People want fruit, veggies and herbs that are free from harmful chemicals. There's also a call for limiting transportation, leading to maximum freshness at delivery and less preservatives during transition. Bringing agriculture to the city shortens transportation mileages and lessens pollution for the environment. Farming vertically leads to higher quantities and qualities of food grown locally.

03. Rooftop gardens and farms provide many aesthetic benefits: recreational, leisure, relaxation as well as urban environmental benefits: absorbing heat, decreasing smog, reducing rain run-off.

According to the National Research Council of Canada (2002), rooftop gardens reduce energy demand through shading, evapotranspiration, and improved insulation values. They can reduce the heat island effect, which can reduce smog and problems with heat stress. They can also help improve storm water management by delaying run off and thus reducing strain on sewers and by filtering pollutants.

NOBLE ROT ROOFTOP GARDEN | FIGURE 4

RELEVANCE

Is agriculture a viable concept for an urban environment? The idea and pursuit of city farming is still relatively underdeveloped. Many cities in the United States have taken steps to facilitate its integration, but there's significant progress to be made. This concept is relevant to the field of architecture because of the growing concerns of population and urbanization. To sustain the growing population, we will need to produce more food. With the increased trend in city living, we can decrease transportation costs and pollution by integrating food production directly into the city.

The investigation of the feasibility of urban agriculture will begin during the ARCH 771: Advanced Architectural Research Studio. During this portion of the thesis, current design characteristics of single-story greenhouses will be inventoried, analyzed and built upon. This information will lead to the comprehensive design of a multi-story greenhouse facility as the final thesis typology.

PROJECT TYPOLOGY

STEDSANS ROOFTOP FARM | FIGURE 5

VERTICAL FARM
multi-story greenhouse

The primary typology of Relocated Roots is a vertical farm to grow fresh produce within the city.

GUATEQUE CO-WORKING SPACE | FIGURE 6

OFFICE + ADMIN
support spaces for the farm

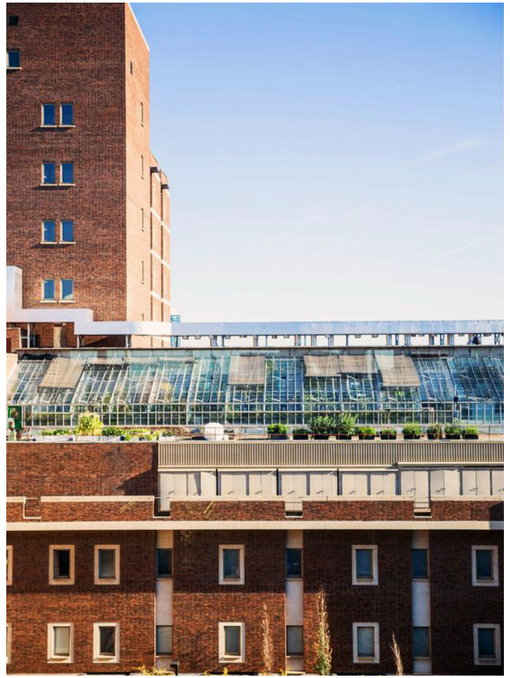
The secondary typology of the new building are offices and administrative support spaces.

Relocated Roots is a design thesis that integrates agriculture into the urban environment within an underutilized and vacant space: like a seed drifting in the wind that finds a home in an unlikely place. Downtown plot revivals are valuable and benefit the immediate community for many reasons.

Redesigning an untapped plot of land is like reintroducing a piece of the community's history. An urban plot is an excellent opportunity to be modernized and reconstructed into a functioning space. Incorporating the site's existing elements into a new design blends the city's history with contemporary ideas and architectural techniques.

Relocated Roots is a site revival architectural new build because of its project goals. The redesign of 407 New Street aims to facilitate the transition of farming into the city, promote social change by pushing boundaries, and reinvigorate a community with this new typology. In order to achieve this, a site in need must first be selected and analyzed.

An underutilized site provides an ideal opportunity to achieve these goals. An vacant parking lot will serve a community need but may have deteriorated and become a place of untapped potential. By adapting and reusing an underutilized urban site, Relocated Roots hopes to overcome the stigma and grow into a symbol of hope for the future.



UNIVERSITY OF ALBERTA GREENHOUSE | FIGURE 7

PRIMARY TYPOLOGY: VERTICAL FARM

Relocated Roots is designed to be a futuristic farming facility. It is classified as a “greenhouse” typology, which falls within the agricultural building category. It also will host office and administrative support spaces, and a market plaza - both of which fall within the commercial building category. Relocated Roots could be defined as a mixed-use building as there are multiple categories of building elements, although the primary typology is greenhouse.

The main difference between the Relocated Roots’ greenhouse and typical greenhouses are the number of stories or floors. Relocated Roots aims to provide a commercial-scale amount of produce, therefore it will need to maximize the footprint by growing up, not out. The design of multiple stories presents many challenges in terms of MEP, but fortunately the new build component of the design will attempt to address the design of these systems.

While a multi-story greenhouse isn’t exactly brand new, it also isn’t very common. The premise of Relocated Roots is to investigate how to make architecture a method of promoting and delivering social change. By using this up-and-coming typology, the project intends to capitalize on this formative idea to make a lasting impression.

ROMAINVILLE VERTICAL FARM | FIGURE 8

GOTHAM GREENS URBAN GREENHOUSE | FIGURE 9

VERTICAL HARVEST

VERTICAL HARVEST EXTERIOR | FIGURE 10

Vertical Harvest is an urban vertical farm designed by E/Ye Design. The three-story hydroponic farm is a start of the art greenhouse with multiple rooms acting as its individual micro-ecosystems. The greenhouse is designed to be well-regulated to maintain heat, moisture, uv light and carbon dioxide levels. While an unlikely place, the design actually fits into the side of an existing public parking garage. Vertical Harvest was built in Jackson, Wyoming and when the building opened in May of 2016, the design received national recognition for its innovative design and business model.

While it is small, the design is robust. Its footprint measures only 150 feet long by 30 feet wide, the 13,500 sq ft of downtown greenhouse produces 50,000 pounds of produce annually – and that's just its beginnings. Vertical Harvest expects to be producing 100,000 pounds of produce in under three years.

The building's footprint occupies only 1/10 of an acre and produces the amount of food traditionally grown on five acres worth of land. That's 1/50 of the fields required instead grown directly in the city next to a parking garage. In addition to its impressive yield, the greenhouse operates year-round in the harsh Wyoming climate. Its ability to accomplish this is in its building systems: The vertical farm uses a hydroponic growing method. This process speeds the growth of produce by almost double and requires no soil. It uses 90 percent less water than traditional growing methods because the water can be filtered and recirculated.

The designer of Vertical Harvest is an actual architect named, Nona Yehia. She and Penny McBride are co-founders who believe in the power of architecture to build communities. They recognized a lack of fresh produce in their community, a strain on transported goods, and a nearly impossible growing season. Despite these challenges, the founders fought for to put the project on the ground and immediately, the response was overwhelming. This idea of finding a community need and providing an architectural response is the premise behind Relocated Roots. **Vertical Harvest demonstrates that in even the harshest climates, the toughest budgets and sharpest critics, architecture can push the boundaries of design.**

"It started as a social mission," explained Nona and Penny.

"We wanted to make a difference in the community and inspire others to do the same."

A FUTURISTIC FARMING FACILITY

The design for Vertical Harvest responds to the environment very specifically. The grow lights used to supplement the natural sunlight require a certain amount of energy. But the particular kind they use creates net energy savings over the amount of energy needed to import produce. Their design also creates a significant reduction in the amount of land required to produce the same amount of yield while also using 90% less water. The design also integrate a highly-efficient heating system to supplement the cold Wyoming winters.

The greenhouse's primary function is to give back to its community through its high quality produce grown right in town. Prior to its build, Jackson would import almost all of its fresh produce from Mexico or California. Given the town's location among the mountains, there are times of the year where transportation trucks physically cannot deliver fresh produce to the local stores. Vertical Harvest closes the gap between imported food and locally grown food and by doing so, narrows the mindset that food must be grown far away and be delivered in. By allowing access for visitors to view the growing area without contaminating the crops, Vertical Harvest introduces the citizens to their food source and inspires locals to take back their food.

VERTICAL HARVEST CONCEPT RENDERING | FIGURE 11

NATURAL LIGHT
reduces energy use

The entire south facade is made of glazing to maximize the amount of sun for the plants. The engineers found the climate to serve minimal concern for solar heat gain.

SOUTH FACING GLAZING | FIGURE 12

HYDROPONIC
soil-less growing trays

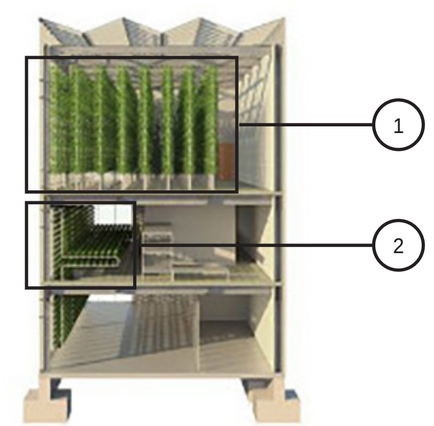
A concentrated liquid tailored to each species of plant - typically includes nitrogens, potassium and phosphate. The controlled environment optimizes flavor and nutrition.

GROWING TRAYS UNDER LED LIGHT | FIGURE 13

CONVEYOR SYSTEM | FIGURE 14

Vertical Harvest contributes its ability to yield so many crops to its unique stacked greenhouse design. The first two floors are assembled with each floor cultivating a different type of produce. A sophisticated conveyor belt design, or carousel system with growing trays, constantly revolves plants to maximize the natural south facing sunlight. The third floor operates a little bit differently. It is assembled similarly to a traditional single-story greenhouse, with a unique vertical tomato growing system. This original system has a steep learning curve, but once the systems become optimized, the vertical farm will provide so much good for the community.

VERTICAL TOMATO PLANT | FIGURE 15



TRANSVERSE SECTION | FIGURE 16

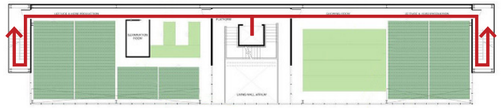
01. The vertical tomato growers This system provides the vertical support for tomatoes while minimizing space.

02. The conveyor belt / carousel This system rotates the crops evenly so sunlight is distribute equally.

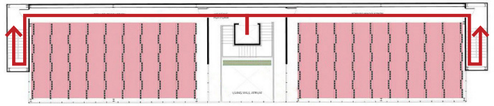
STEEL FRAMING | FIGURE 17

STRUCTURE

Vertical Harvest utilizes a light weight steel structural frame with concrete over metal decking floors. The frame is made of wide flange steel columns, girders and joists. The framing is joined together with moment connection plates and bolts. The exterior glazing is connected directly to the framework with no additional insulation. This likely mean the glazing is high performance in order to combat the winters. In all, the structure is simple and cost effect to maximize the budget.

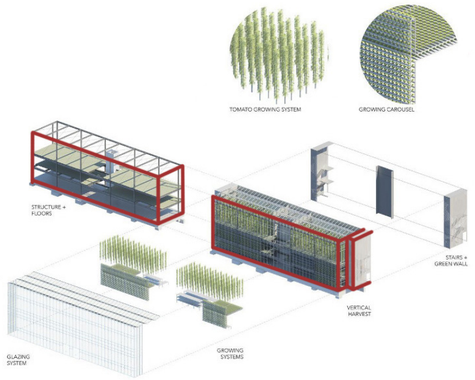


VH THIRD FLOOR | FIGURE 18



VH SECOND FLOOR | FIGURE 19

V FIRST FLOOR | FIGURE 20



SYSTEMS ASSEMBLY | FIGURE 21

CIRCULATION

Because Vertical Harvest has such a small footprint, its circulation must be simple and concise. There is a central “core” in the design with the main circulation to the rear. There is a three story atrium space in the center as well.

GEOMETRY

The geometry of the design is simple and concise as well. The building is a solid rectangle with no dramatic variations in form. The two stairwells on the ends provide a slight articulation in the form, but overall very sleek and neat.

BAY CONSTRUCTION | FIGURE 22

HIERARCHY

The simple form and structural framing of the design lends itself well to forming visual hierarchy. The thickest components are the columns, which aid in drawing the eye vertically along the farm. The next are the girders, which allude to the length of the building, and finally the thin curtain wall mullions which are a strong contrast.

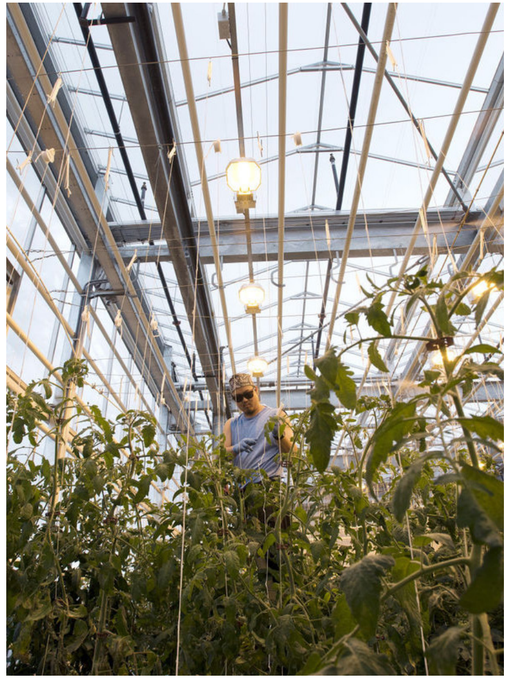
UNIT TO WHOLE

a modular approach

The entire south facade is made of the same repetitious pattern. At each bay, both regular and cross bracing is integrated to reduce deflection. This creates the appearance of a unit within a whole facade.

Vertical Harvest is similar to the other precedent studies in its intention to inspire social change. Just as the others attempt to, it strives to make a meaningful difference in the community and impact real lives with its actions. Its work showcases modern growing methods so much so that communities all over the country are interested in replicating their design. This system of inspiring others to make a difference is the goal of Relocated Roots. It differs however in that it's specifically an urban farm. The other precedent studies tackle the mission behind the theoretical premise, but this project specifically addresses both the typology and the underlying goal of the thesis. It provides actual precedent for designing this kind of typology. It gives insight into the quantitative numbers of vertical farm design. It lends knowledge into the structure, floor planning, and vertical system of greenhouses while also succeeding in its objective to inspire others.

Vertical Harvest contributes to the theoretical premise of the thesis in its typology and mission. It embodies both the goals of Relocated Roots and it provides knowledge of modern growing techniques. The design contributes insight into the structural and glazing requirements needed to provide for so many crops, and it adds a level of showmanship to the growing process. By designing a display of their systems, they're exhibiting great pride and care in their work. This translates into a meaningful example of urban agriculture.



THRIVING CROPS | FIGURE 23

GROWING TRAYS | FIGURE 24

The theoretical premise of Relocated Roots gains a new perspective of showmanship. A building's design can promote a message with a new typology and contemporary techniques, but it can also convey a sense of pride in the work with designs for displays. Perhaps the architecture can symbolize sustainability and the well-being of the environment and the interior design instills a sense of accomplishment in the successful integration of urban agriculture.

VIA VERDE - THE GREEN WAY

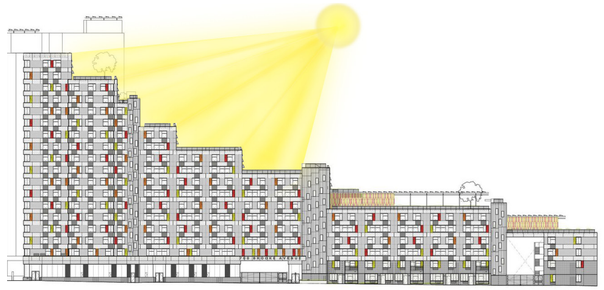
Via Verde means, “The Green Way.” And this sustainable residential development encompasses just that. This design by Dattner Architects and Grimshaw is located in the Bronx, New York and is revolutionary for its scale and affordability. Its design won the first juried design competition for affordable and sustainable housing in New York City. Totaling 300,000 sq feet, Via Verde hosts 222 apartments, a 20 story tower, 13 stories of mid-rise duplex apartments, and 2-4 story townhouses. It also has 3,700 sq meters of open space for green roofs, gardens and even a Christmas tree farm.

Via Verde marks a design commitment to create the next generation of affordable housing and sustainable living. This design was created to celebrate the integration of landscape and city, garden and urban building. It utilizes cross ventilation, solar shading, photo-voltaic canopies, high-efficiency mechanical systems, and energy conserving appliances and plumbing.

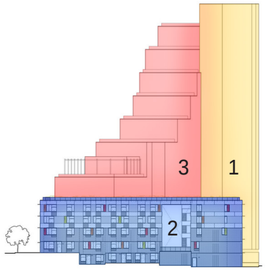
Dattner Architects and Grimshaw’s design is visionary. In a place where life can be bleak, they provide an architectural solution that substantially improves people’s lives. While the project may not make enough revenue to meet the affordability of the apartments, the tax deduction of rooftop gardens and financial support from the city allow hundreds of New Yorkers to live in a beautiful and healthy place. This case study shares with the others in that it makes a difference in people’s lives in an iconic and socially influential way.

While it shares in the values and mission of the other cases, Via Verde is typologically different from the thesis premise and other case studies. It primarily serves as a holistic residential complex for hundreds of people. It is included in the research study because it is a remarkably sustainable and environmentally conscientious design. It captures the integration of the land into the urban environment while invigorating a community. It embodies the goals of Relocated Roots’ premise despite its differing typology.

VIA VERDE EXTERIOR PERSPECTIVE | FIGURE 25



WEST ELEVATION | FIGURE 26



SOUTH ELEVATION | FIGURE 27

NATURAL LIGHT

Via Verde maximizes natural light for its rooftop terraces and units. The rooftop gardens and private patio spaces are stepped down in order to maximize the angle of sunshine. This decision creates a pleasing visual rhythm in the overall form of the building while also providing an appropriate consideration for the gardens. The photo-voltaic panels are also placed against these “steps.” By placing them against the walls, the PV panels are not obstructing the views or beauty of the design. The units are also able to receive plenty of natural light due to its simple form not casting shadows.

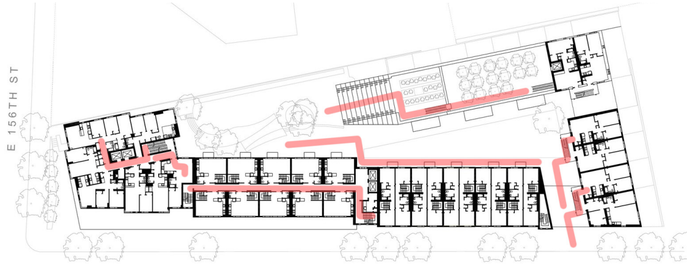
MASSING

There are three main masses within the design for Via Verde. The first is referred to as the “tower.” This space is the tallest and most rigid in form of the three masses. It houses the bulk of the affordable units. The next is the duplex apartments. It is the shortest of the masses and has the most community oriented rooftop space. The last are the terraced units. This mass is the most visually interesting part of the design and it connects the two drastically different heights of the other two masses. By stepping the design down using this mass, the entire building appears unified and intentional.

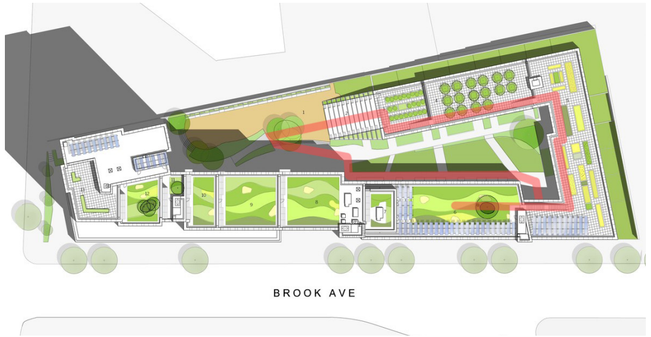
CIRCULATION

Circulation through Via Verde is very simple and straightforward. Their floor plans for units follow a double-loaded corridor pattern in a linear arrangement. The units are square and modular. Their outdoor circulation is also linear. Each exterior space is connected by one staircase and leads up the rooftops in a stair formation. This allows users to “walk” up the city via the rooftops, with gorgeous views to the city.

VIEW FROM ROOF | FIGURE 28



TYPICAL FLOOR PLAN | FIGURE 29

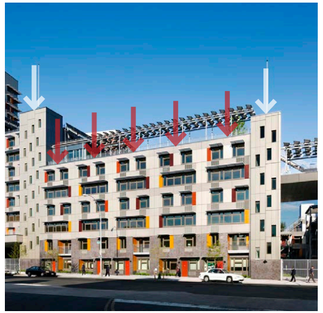


SITE PLAN | FIGURE 30

COURTYARD PERSPECTIVE | FIGURE 31

ADDITIVE + SUBTRACTIVE

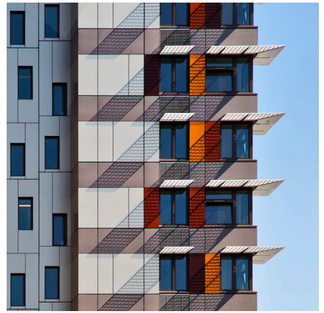
The building's massing also uses additive and subtractive properties. If the "base" building height sits at the top of the shortest mass, the interior courtyard space is cut away and placed on top of the "base" height. This allows for a visual balance while still allowing for hierarchy in the design and fulfilling programmatic elements.



EXTERIOR FACADE | FIGURE 32

REPETITION

The material facade of Via Verde uses a repetitious coloring and patterning of windows and doors. All of the corners feature the same visual patterning and type of windows, while the units utilize the same colors per floor. Whole the patterning looks repetitious, it conveys a sense of playfulness and comes across as unified and clear.



EXTERIOR FACADE | FIGURE 33

GEOMETRY

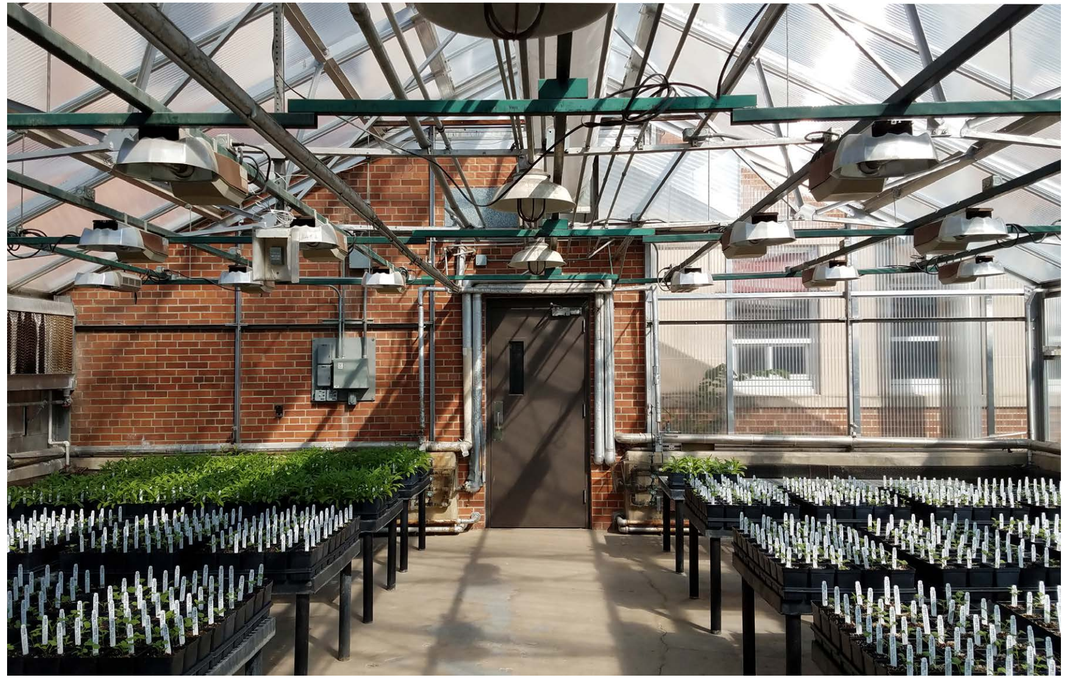
The overall geometry is rectilinear with only slight variation. The single example exists in the floor plan; it utilizes rectangles slightly rotated acutely to form a trapezoidal footprint. Otherwise, the rest of the design comes together in 90° angles. The rooftops, material paneling, furniture, and plant beds are all rectilinear.

VIA VERDE EXTERIOR PERSPECTIVE | FIGURE 34

DOES IT ALTER THE PREMISE?

Via Verde contributes to the theoretical premise of Relocated Roots by providing a world-renown solution that embodies the ideals and goals of the thesis. The redesign of 407 New Street wants to promoting and advocating social change – that is, to incorporate agriculture into their cities, and healthy food into their diets. Via Verde accomplishes this very concept, but for a different typology and city. It demonstrates a shifting mindset in the integration of landscapes in cities, and reaffirms the theoretical premise in its goals.

The theoretical premise is not altered by the conclusions drawn by Via Verde. Instead, the project reaffirms the underlying values and mission of the thesis. Dattner Architects and Grimshaw designed an awe-inspiring project that symbolizes a shift in the mindset of city design. The design of Via Verde represents a commitment to changing the culture and society of the Bronx, a historically tough part of the city. By undertaking a struggling site, incorporating principles of sustainability, and transforming it into a place of community and growth, the designers demonstrate that architecture can transcend its walls and roofs to become a symbol of possibility.



USDA GREENHOUSE INTERIOR | FIGURE 35

NON-TYPOLOGICAL RESEARCH

The Bioscience Research Laboratory (BRL) is a United States Department of Agriculture (USDA) maintained research facility on the North Dakota State University main campus in Fargo, North Dakota. The facility maintains six greenhouses with nine controlled spaces for experiments. This precedent study investigates Ranges #3 and #4, which are combined within a single story greenhouse design.

This precedent research study is non-typological; it investigates the thermal performance of the greenhouse typology, but not the function of a socialization space.

The BRL Greenhouse is exclusively a research facility. Its sole function is to house experiments and facilitate the development of ideas and knowledge in plant growth. This facility differs from the other precedent case studies in this primary function: it doesn't cultivate produce for consumption. Instead, it cultivates produce for learning. The conceptual foundation behind the BRL Greenhouse is learning, not eating. It doesn't engage the community in the way the others do, and it doesn't try to. A federal research facility is not the typology for community engagement, which is an appropriate response for their work.

The precedent research is conducted in pursuit of simulating conditions to reflect the reality of a multi-story greenhouse design. Its intention is to learn about the construction and behavior of single story greenhouses in order to apply the theories and techniques to the thesis design.

The study comprehensively examines the existing conditions of a single story greenhouse in a harsh midwestern climate. By inventorying this built design in a quantifiable, measurable investigation, the effectiveness of its thermal performance can be evaluated and conclusions can be drawn based on its results. The study begins by examining the effectiveness of an existing single story greenhouse design, then contrasts its findings with simulation results of the same design. The study then uses the combined data to determine the accuracy of the software. Once the software is validated or discredited, the findings will inform design decisions for an urban multi-story greenhouse.

A comprehensive report of the research findings is included with this thesis located in the official North Dakota State University Repository.

PROJECT ELEMENTS

COMMERCIAL SCALE GREENHOUSE | FIGURE 40

VERTICAL FARM | GREENHOUSE

Because of the limited open space in the city, finding workable farmland is challenging and sometimes nearly impossible task due to substantial property value costs. A building's rooftop provides an innovative and cost effective place for growing and nurturing urban agriculture. By utilizing an otherwise wasted space, the community can benefit from a educated redesign. Constructing a multi-story vertical farm atop a building can cultivate fresh produce for the surrounding community while possibly reducing the heat island effect of cities. This major project element is the central element within the thesis design.

There is a societal demand for high-quality food in cities, a call to reduce transportation pollution and a focus on sustainable architecture. A greenhouse can provide a solution that accomplishes these goals while also highlighting advances in agricultural technology. Though greenhouses are typically single story, a taller, multi-story design will both embody traditional techniques and build upon them with contemporary strategies. A vertical farm can provide a greater amount of fresh produce in a cleaner and more efficient facility than traditional farming, and thus demonstrate the feasibility of the project.

REGEN VILLAGES VERTICAL FARM | FIGURE 41

EL MERCADO ROMA | FIGURE 42

RESTAURANT

casual healthy eating

Relocated Roots intends to introduce a casual healthy eating restaurant on the first floor of the design. This space will provide opportunities for citizens to gather, dine, and enjoy healthy eating.

FARMER'S MARKET

Eating and drinking are common reasons for people to gather. With the availability of farm-fresh produce, a small restaurant and marketplace provide perfect opportunities for people to connect within Relocated Roots. Socializing with others is a fundamental part of a strong and lively community. By incorporating food-related community spaces, the design will integrate the agricultural component of the design with the community, adding consistent community exposure to the building's main function. Continual exposure and function integration will help agriculture assimilate into the urban environment. The more people are introduced and interacting with the farm produce grown in their city, the more likely they will become readily familiar with the concept of urban agriculture.

These spaces are intended to be fun and informal settings for community members to gather and relax. Both spaces will try to reflect nature through its spatial form and overall aesthetic. The interior design of the restaurant will need to create intimate yet inviting spaces, while the exterior plaza will need to showcase products and inspire conversations. By designing spaces for socialization and nature, the design attempts to bridge the gap between people's innate longing for nature and the disconnection of city living.

LAFAYETTE FARMER'S MARKET | FIGURE 43

CLIENT DESCRIPTION

PRIMARY CLIENT

The multi-story greenhouse atop Relocated Roots is commissioned by an urban agriculture company called Gotham Greens. Gotham Greens is a fictional client but a real company. They own and operate four commercial scale urban farming facilities across the United States, spanning approximately 170,000 SF of technologically advanced, 100% clean energy powered, climate-controlled rooftop greenhouses.

GOTHAM GREENS GREENHOUSE INTERIOR | FIGURE 44

GOTHAM GREENS FOUNDERS + CAO | FIGURE 45

"inspired by innovation and technology

driven by a sense of duty to address ecological issues facing our agricultural system"

When Gotham Greens built its first greenhouse in 2011, it became the first commercial scale rooftop greenhouse in the United States. Located in the Greenpoint neighborhood in Brooklyn, New York, Gotham Green's facility represents a shift in the industry of urban agriculture. No longer was city farming a seasonal community gardening concept. Their work transformed the industry into a year-round commercial scale farming enterprise.

In 2014, Gotham Greens constructed a second greenhouse in Brooklyn. This time, on the rooftop of Whole Foods Market store. This greenhouse represents another first in commercial scale urban agriculture: a farm facility fully integrated into a supermarket. In the last three years, Gotham Greens has open two additional greenhouses in New York City and Chicago and has expansion plans to operate in cities all over the country.

CLIENT DESCRIPTION

SECONDARY CLIENT

Relocated Roots is owned by one party but has several building users. The primary client, Gotham Greens, is the owner of the building, and they intend to lease space to a secondary client, Urban Harvest. Urban Harvest is an entirely fictional client who will rent a portion of the building for a casual restaurant and occupy the surrounding plaza during the summer months for their weekly indoor/outdoor farmer's market. Urban Harvest is a fictional company who specializes in public event organization and tourism. Their mission is to organize and integrate other local farmers into the Relocated Roots weekly market. Their investment into the building allows them to build their branding as a promoter of sustainable farming and public outreach. Urban Harvest intends to occupy the first floor of Relocated Roots with appropriate support facilities for their staff.

MARKET SHOPPER | FIGURE 46

GOTHAM GREENS EMPLOYEES | FIGURE 47

GOTHAM GREENS

primary client, building user

The primary client and building users of Relocated Roots are the employees and workers + the crops. The final design will consider their needs and attempt to provide proper conditions for optimal work and growing.

FARMER'S MARKET EMPLOYEES | FIGURE 48

URBAN HARVEST

secondary client, building user

The secondary client and building users of Relocated Roots are the employees of Urban Harvest. Their staff will require appropriate work conditions which include clean facilities for food prep and proper egress for their patrons.

USER DESCRIPTION

RESTAURANT PATRONS

To ensure product quality and safety, Gotham Greens employees are the only users permitted within the vertical farm. Their employees and plants are considered the primary users of the building. There will two departments for Gotham Greens employees: office and administrative, and greenhouse care. Office employees will focus on tasks like marketing, merchandising, and contracting. The greenhouse employees will manage the systems and care for the produce. There will be an estimated 10 full-time office employees working 8am-5pm, and 20 full and part-time greenhouse employees working varying shifts around the clock. The office employees will not have any physical requirements whereas the greenhouse employees will. Due to the nature of the work, they require the ability to lift 30lbs, stand for long periods of time and perform tasks repeatedly. They will need parking for their staff, as well as loading and unloading space for trucks.
The greenhouse will require many building elements to function successfully:

- Sufficient water sourcing and distribution
- Structural reinforcing for vertical plantings
- Large service elevator for equipment
- Exterior access door for even larger equipment
- Loading docks, pick up and drop off areas

BUILDING EMPLOYEES

The small, community focused restaurant within Relocated Roots will occupy the first floor with access to the exterior plaza and exhibition space. The restaurant patrons are considered the second user of the building. To accomodate them, the restaurant will operate during the day, to provide lunch for downtown business people as well as dinner for tourists and locals. However, the most influential time for it to be used is in conjunction with the farmer's market. The restaurant will provide around 75-100 interior seats, and must allocate parking for the patrons. The restaurant is intended to highlight some of the crops grown in the vertical farm as well as selections from other nearby farmers. The availability of purchasing local produce and enjoying local produce will help promote the message of sustainable urban farming.

MARKET SHOPPERS | FIGURE 49

CINCINNATI CITIZENS

The Urban Harvest Market Plaza is a space for Cincinnati citizens to purchase locally grown foods. This space will be used primarily during the weekends during the summer months: Saturdays and Sundays in May-October. During the non-peak seasons, the plaza will serve as open space for tourism or winter exhibitions. The residents of Cincinnati are the third building user, and possibly the most important.

In the 2010 US Census, there were 296,943 people living in the city. That number can be used to estimate how many people will visit Urban Harvest's Market Plaza. The Farmer's Market Coalition is a nonprofit organization dedicated to providing information and opportunities for farmers. They believe there are many ways to reliably estimate numbers of farmer's market visitors. The most common method is to strategically place staff at defined entry points and take count for every 15-20 minutes. Then, multiply that number by 4 or 3 to get your "hourly" visitors.

In Ruston, LA, they've recorded 858 and 1,509 visitors.
At a population of 22,370, that's 3.8% and 6.7%.

In New Orleans, LA, they've recorded 1,122 and 1,167 visitors.
At a population of 391,495, that's 0.28% and 0.29%.

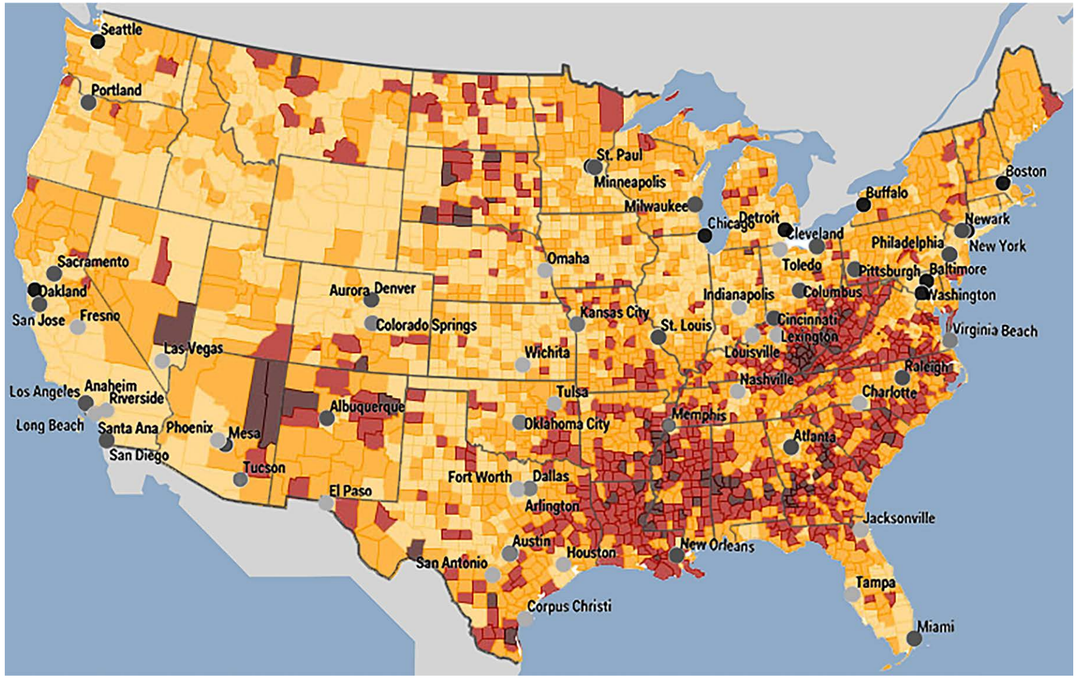
Because New Orlean's population is closer to Cincinnati's than Ruston's, the New Orleans percentages can be used to estimate Relocated Roots' farmer's market numbers:

296,943 x 0.28 = 831 visitors
296,943 x 0.29 = 861 visitors

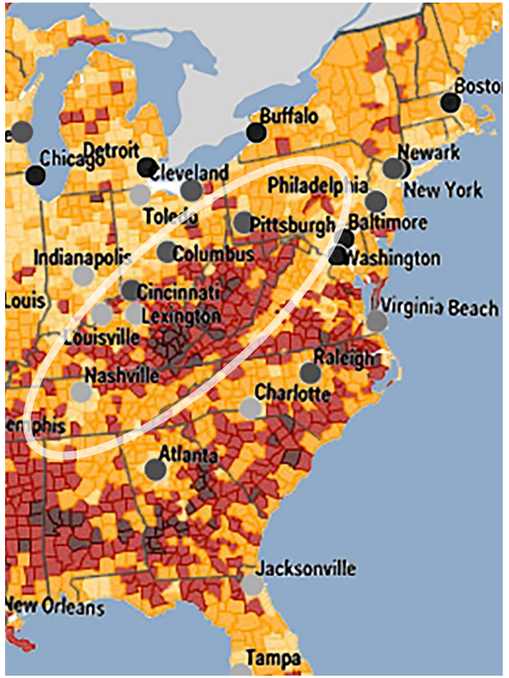
It can be difficult to estimate how many people to plan for, especially when visitor's data is so prone to error. When competing with other well established farmers markets in the area, these numbers seem to be a little unrealistic for the Urban Harvest Farmer's Market. **Planning for a more modest number like 300 people may be appropriate, so long as Relocated Roots will plan to leave space for additional facilities.**

The existing site serves as at-grade parking lot. It is clear that an extensive underground parking structure will be needed to serve the 8am-5pm downtown business people. Fortunately, the Market Plaza will operate on an opposite timetable, so they will have the ability to share space so long as both parties agree.

SITE INFORMATION



MAJOR US CITIES AND FOOD DESERTS | FIGURE 50



MAJOR US CITIES AND FOOD DESERTS | FIGURE 51

SITE SELECTION: REGION

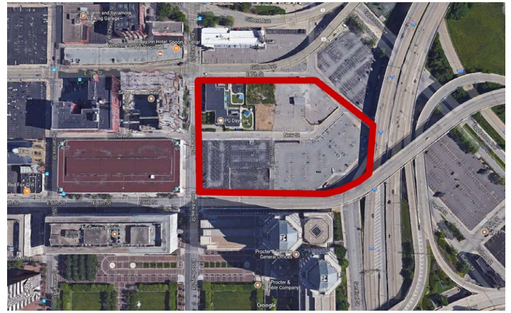
A food desert is an urban area where it is difficult to buy affordable or good-quality fresh food. This map shows the percentage of the population who don't own a vehicle and live more than 1 mile from a grocery store. The darkest colors mean more than 10% of the population live in a food desert. The lighter yellow colors fall closer to 2.5%.

There are two distinct areas of the country where there is a heavy concentration of people who live in food deserts: the first region falls over Louisiana, Mississippi and Alabama. The other covers Kentucky, West Virginia, and parts of Southern Ohio. This particular region is more populated than the other, and has a higher concentration of cities. For this reason, this area provides a better opportunity for implementing social change.

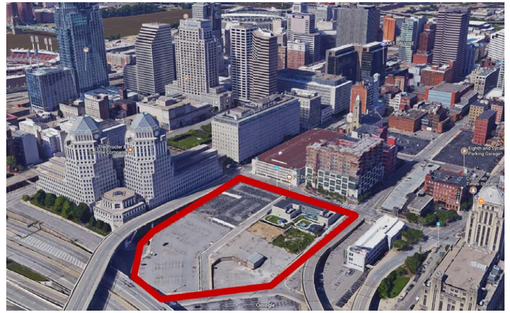
Cincinnati is a city in Ohio that lies right on the edge of this concentration of food deserts. It lies at the intersection of several interstates: 275, 71, 74, 75, 471. The city also has a high percentage of overweight and obese adults. A study in 2010 reported 64.9% of Cincinnati adults are overweight or obese (Gonzales 2014). Access to fresh food is known to be beneficial for combating health problems.

CITY OF CINCINNATI | FIGURE 52

DOWNTOWN CINCINNATI | FIGURE 53



IMMEDIATE CONTEXT | FIGURE 54



AERIAL VIEW, LOOKING SOUTHWEST | FIGURE 55

407 NEW ST, CINCINNATI, OHIO

This specific site is important to the design because it provides clear opportunities for the thesis premise:

01. The site exists within the urban context of a major United States city. It also is a city that lies on the edge of one of the largest concentrations of food deserts in the US. It is the hope that designing a fresh produce facility in this city will inspire smaller communities in the region to do the same.

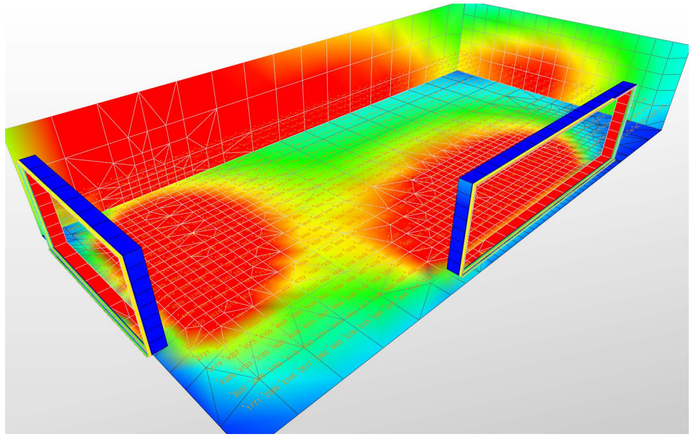
02. The site also exists in a city with extraordinarily high overweight and obese percentages among adults. An urban agricultural facility is appropriate for Cincinnati because it would provide a positive supply of fresh produce for the citizens. Healthy fruits and vegetables are known to reduce weight and health risks. By producing healthy foods so close to the source of the problem, Relocated Roots can provide people the tools they need to better themselves.

407 New Street is important because it is located adjacent to two major interstates. This proximity to vehicular circulation allows for maximum visual exposure. The architecture of Relocated Roots aims to promote and advocate social change, and this visibility will constantly spread the message to the hundreds of people using the interstate.

407 NEW STREET | FIGURE 56

407 New Street has the unique opportunity to revitalize an underutilized part of downtown Cincinnati. The current site is an at-grade parking lot and a redesign emphasizing community could really benefit the city. The site has connections to the interstate and public transit, and has already established itself as a useful asset. It is physically bounded by the interstate, but the noise and views won't bother the plants.

PROJECT EMPHASIS

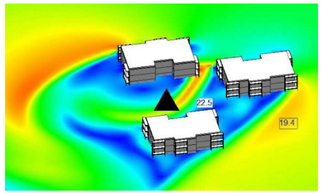


AUTODESK LIGHTING ANALYSIS | FIGURE 57

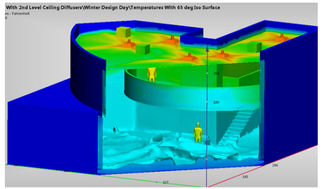
THERMOGRAPHY

visual heat mapping

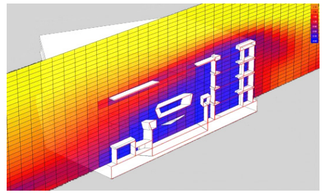
Utilizing infrared radiation to form an image reflecting the physical temperature of a subject.



AUTODESK FALCON | FIGURE 58



AUTODESK CFD | FIGURE 59



AUTODESK CFD | FIGURE 60

THERMAL PERFORMANCE

The material nature of greenhouses and the importance of sunlight in growing inspire a considerable emphasis on the thermal performance of Relocated Roots. Greenhouses are typically constructed using transparent materials like glass or polycarbonate in order to allow sunlight to penetrate and warm the space.

For a project this size, this much glazing would mean a substantial amount of radiant heat with a high window to wall ratio. This causes concern for summer months when the external temperatures are already so high. Multi-story spaces are prone to unequal heat distribution and with the added heat loads, it will be important to address thermal performance goals early on.

More than ever, design tools and technology have the ability to reflect the reality of a building's thermal design. Software like Autodesk CFD, Flow Design, and Revit are increasingly critical in calculating how a building's fenestrations and materials are operating. Simulations of building performance will guide the project to success. The results of early energy modeling will inform many design factors such as massing, material, orientation and window/wall ratios. At the end of the project, the simulation results will also provide justification that the building's thermal performance achieves its sustainability goals.

Identifying strategies in heat gain/loss, optimizing design factors such as massing and materials, and demonstrating their effectiveness will either prove the success of the design, or indicate which areas need attention.

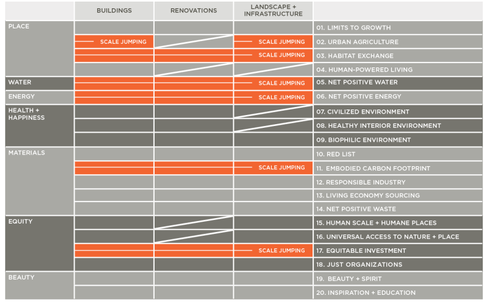
PROJECT GOALS

The Academic Goals of Relocated Roots are focused towards environmental sustainability and the community's social well being. The community and the crops will require different considerations, therefore, the academic goals for the project revolve around achieving two sustainable design certifications:

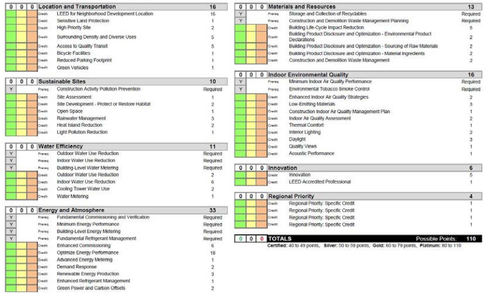
Pursuing a LEED Certification increases the value, environmental integrity, and media exposure of the design. Achieving a Platinum or Gold Rating would ensure the project's sustainability goals are met as well as the promotion and advocation of social change.

Pursing an LBC Certification demonstrates that the building "gives more than it takes, creating a positive impact on the human and natural systems that interact with them." This sustainability design framework aligns with the project's goals of giving back to the community.

Relocated Roots' goals are to conduct research and use that knowledge to design well-informed. It aims to contribute to the design field's understanding and acceptance of city farming. The project learns, discovers and experiments with techniques to integrating urban agriculture.



LBC CERTIFICATION MATRIX | FIGURE 61



LEED CERTIFICATION MATRIX | FIGURE 62

USGBC LEED CERTIFICATION

goal or platinum certification

LEED Gold®: 60-79 points earned
LEED Platinum®: 80+ points earned

LIVING BUILDING CHALLENGE

petal or living building certification

Requires at least three of the seven Petals, one of which must be either Water, Energy or Materials.

WINDY CITY HARVEST | FIGURE 63

PROFESSIONAL GOALS

Due to its unique subject matter, it is unlikely that Relocated Roots will directly relate to the typological specialties of typical architecture firms. Instead, the professional goal of this thesis is to convey creativity, resourcefulness and a profound compassion for the environment. Building familiarity with certification programs, knowledge of sustainable design practices, and skills for software modeling are also professional goals of this thesis project.

Relocated Roots aims to demonstrate my ability to conceive and articulate an idea, research and examine thoroughly and communicate a quality design effectively. At the conclusion of the project, the professional goal of Relocated Roots will be to exhibit my technical abilities and personal ideals. The thesis is crafted with great care and integrity in hopes that it will translate into my capabilities as its designer.

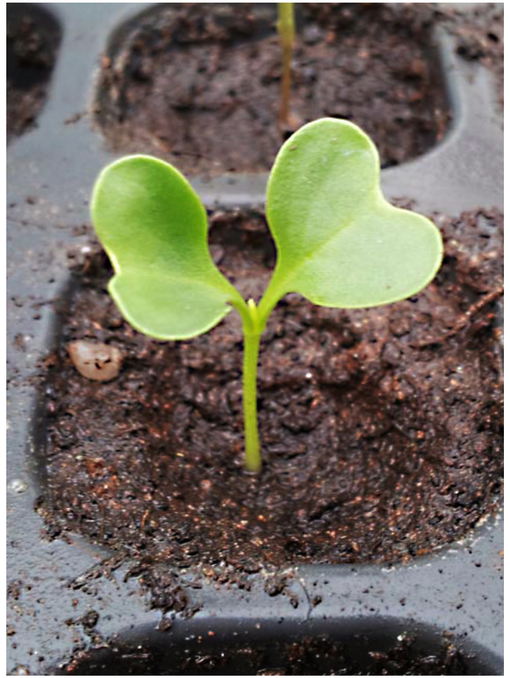
PERSONAL GOALS

There's a lot to be said about passion - If you love what you do, you'll never work a day in your life. My academic career in Architecture and my personal affinity for gardening have been building towards this project for years. With this thesis, I saw the opportunity to weave these two passions and try to create something truly meaningful.

More than anything, I want Relocated Roots to be the best work I have ever done. The concept of urban agriculture is so new and formative that it needs to be addressed more creatively, more intentionally, and more technically than any studio or professional project I have ever designed. I hope to recognize the challenges of urban agriculture and work towards finding a beautiful, environmentally focused, comprehensive design. It is my earnest hope that one day, I'll look back at this time in my career and feel proud to have pursued Architecture as a method of promoting social change.

"All of the Flowers of all the Tomorrows
Are in the Seeds of Today.."

- Native American Proverb



SEEDLING | FIGURE 64

A PLAN FOR PROCEEDING

DEFINITION
of research direction

1. Theoretical Premise

How can architecture promote and advocate for social change, while facilitating the integration of agriculture into the urban environment?

Areas of focus include analyzing symbolic architecture and design that significantly impacts a community. LEED certified and LBC buildings will be given priority for their sustainability emphasis. The investigation will strive to find similarities between the projects. The research will be done in the form of precedent studies analyzing specific attributes such as extraordinary circumstances, bold goals and impressive success.

2. Project Typology

Multi-story Greenhouse

An investigation into the greenhouse typology will be included in the thesis project. Investigating the elements of greenhouse design will contribute to the development of a design with multiple stories. Areas of focus include structure, ventilation, growing techniques and optimal conditions. The research will be done in the form of a comprehensive case study with CFD simulations and literary review.

3. Historical Context

History of agriculture + the beginnings of vertical farming

Setting the historical context for the design will be important to the project. Research into the origin of agriculture and its affects on society will provide both knowledge and inspiration for this community-driven design. Because vertical farming is a relatively new concept, investigating its beginnings will provide insight into its challenges and necessities.

4. Site Analysis

A comprehensive investigation of 407 New Street

An analysis of the site will be required for the design. By inventorying site elements like circulation, sun, wind, climate, etc. the design can attempt to maximize opportunities.

5. Programmatic Requirements

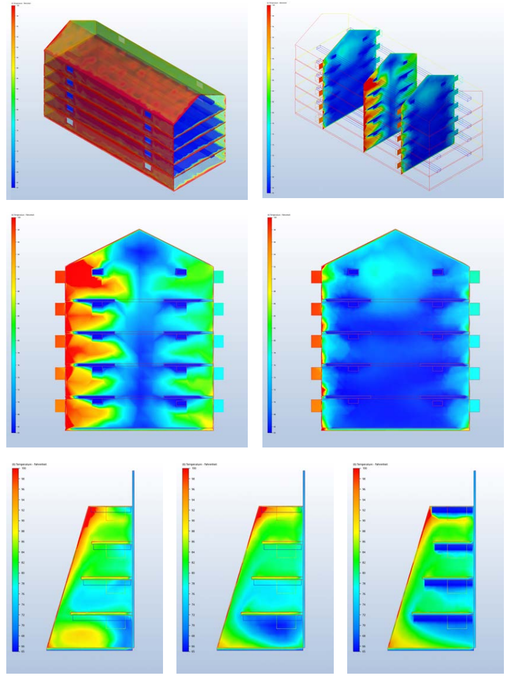
Research into size requirements

In order to achieve performance goals, an adequate amount of space will be required for the design. Precedent studies into other successful vertical farms will serve as the basis for the space allocation numbers. The final square footages will come from site inventory and schematic design.

METHODOLOGY
a system for research conclusion

At the conclusion of the proposal, a digital site context model will be developed for Sketchup, Revit and Infraworks. This model will provide insight into contextual considerations such as massing, solar orientation and circulation. Utilizing Revit Massing and Autodesk CFD, many design masses will be explored early in the design process. Several options developed from the context model will be assessed via thermal simulation to determine which forms successfully perform. The most promising iteration will then be fitted with spaces as determined in the space allocation charts. Once the massing has accommodated the project program, further development of the design will proceed without major design changes.

Due to the iterative nature of simulation, a thorough method for documenting design options will need to be developed. A considerable amount of time will be dedicated at the front end of the design process for schematic massing. A method for comparing the iterations will also be critical for assessing the performance of each mass. The final design will be completed by mid-semester critiques on March 5th. The remainder of the semester will incorporate the feedback received and final production will begin.



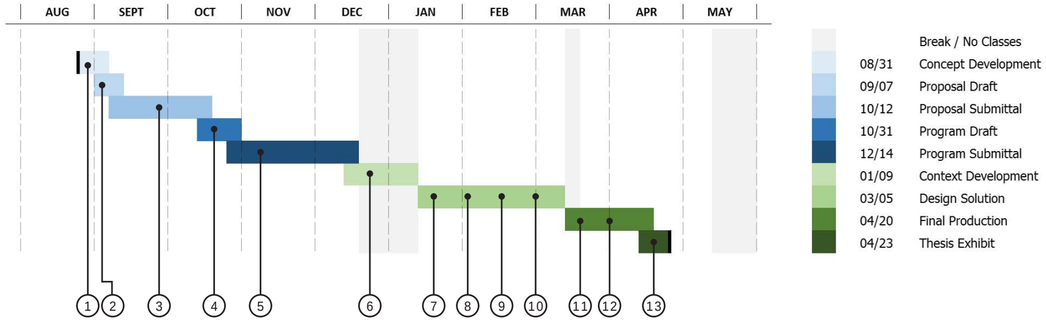
CFD SIMULATIONS | FIGURE 65

PROCESS DOCUMENTATION

The investigation of design options will occur both artistically and digitally - through the use of hand sketching, model making, and computer representation: BIM and CAD. Direct feedback from the thesis advisor will be incorporated into the design project weekly and in-studio critiques from peers will be considered accordingly. All physical design development materials will be preserved in well-maintained sketchbooks and binders. Research and image sources will be recorded and cited as referenced.

The design process will be recorded within a single comprehensive document, from initial proposition through precedent research and investigation of design options. The completed project book will also include the final design solution. The final thesis exhibit will be installed during the week of April 23rd through May 11th, 2018. A complete record of the thesis project will be submitted to the North Dakota State University Institutional Repository to be accessible by ALA students and the general public.

SAMPLE OF THE ITERATIVE PROCESS | FIGURE 66



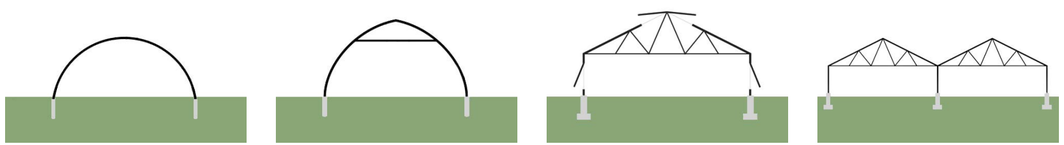
FALL

1. theoretical premise development
2. project proposal + peer feedback
3. project proposal: precedent studies + typologies
4. project program + peer feedback
5. project program // space allocation + literary review
6. develop context model // physical + digital

SPRING

7. schematic massing // initial performance analysis
8. floor planning + spatial organization
9. section, elevation and sun studies
10. mid-semester critiques
11. incorporate feedback and finalize development
12. presentation production
13. install final exhibit and thesis reviews

GREENHOUSE STYLES



GREENHOUSE TYPES | FIGURE 67

Round Arch

Cost: Relatively inexpensive
Structure: Simple, no trusses
No foundation for single stories

Light: Excellent all day long
Align: Long axis North to South
Snow: Poor performance, does not shed well

Pros: can be hundreds of feet long
Cons: difficult to ventilate

Gothic Arch

Cost: More expensive than round
Structure: Simple structure
May add cross bars in center

Light: Excellent all day long
Align: Long axis North to South
Snow: Excellent - sheds well, beware snow gathering around base

Pros: can be hundreds of feet long
Cons: difficult to ventilate

Traditional

Cost: Engineered trusses are costly
Structure: Very sturdy, good long term. Will require foundation.

Light: Excellent all day long
Align: Long axis North to South
Snow: Excellent - sheds well

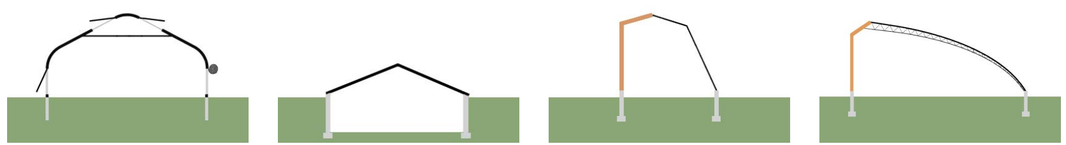
Pros: Most popular style, easy to ventilate due to straight surfaces
Cons: Expensive

Gutter Connect

Cost: Expensive, especially commercial scale
Structure: Will require foundation, option to remove sidewalls

Light: Excellent all day long
Align: Long axis North to South
Snow: Poor performance

Pros: Great for large operations
Cons: Precipitation collects in gutters



GREENHOUSE TYPES | FIGURE 68

Gothic Traditional

Cost: Same as Gothic Arch
Structure: No foundation necessary

Light: Excellent all day long
Align: Long axis North to South
Snow: Excellent - sheds well

Pros: Easy to ventilate due to straight surfaces
Cons: Rounded rigid glazing can be expensive

Walipini

Cost: Expensive in some regions
Structure: Sandbag or cinder block walls

Light: Poor morning and evening
Align: Long axis North to South
Snow: Poor performance, collects

Pros: Thermally insulated
Cons: Animals and people can walk right over it

Passive Solar

Cost: Same as Gothic Arch
Structure: Engineered

Light: Poor morning and evening if using insulated walls
Align: Long axis North to South
Snow: Excellent - sheds well

Pros: Energy savings
Cons: Angle of glazing reduces usable vertical space

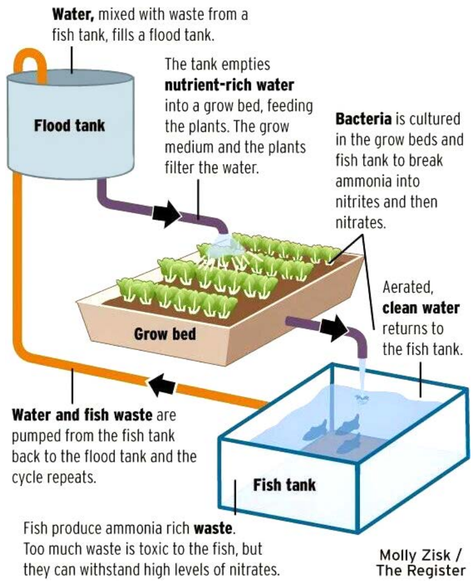
Chinese

Cost: Same as Gothic Arch
Structure: If commercial, long spans and trusses are needed

Light: Poor morning and evening if using insulated walls
Align: Long axis North to South
Snow: Excellent - sheds well

Pros: Good for cross ventilation
Cons: Angle of glazing strains use

MODERN GROWING TECHNIQUES



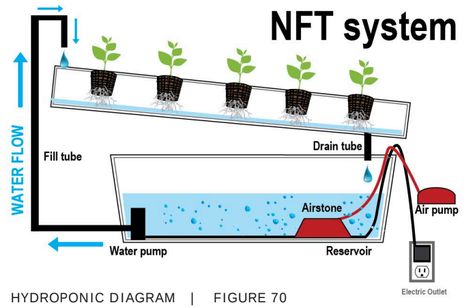
AQUAPONIC DIAGRAM | FIGURE 69

AQUAPONICS
fish integrated, water solution

Hydroponics is a modern farming technique that incorporates the use of fish waste as a nutrient for plants. The diagram to the left describes the process of hydroponics: nutrient-rich water leaves the flood tank to feed the plants, the plants break down the ammonia into nitrates which cleans the water. The clean water is returned to the fish where they live and produce waste. Fish waste contains ammonia, which is pumped back up the flood tank where it is mixed with other nutrients beneficial to the plant.

This type of growing is symbiotic, where both the plants and the fish benefit from the relationship. It becomes a micro-ecosystem where the plants and fish exist in harmony. Because the two benefit one another, Aquaponics significantly reduces water use, even more than hydroponics and aeroponics. It uses only 1/10th of the water needed for traditional soil farming. It relies on the nature of plants and fish to recycle the water and filter out the harmful chemicals.

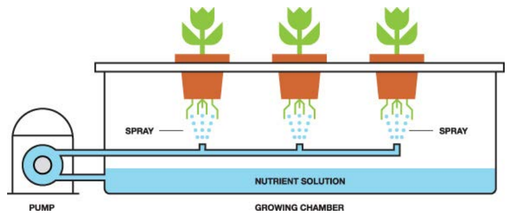
Relocated Roots will utilize modern growing techniques in its vertical farm design. The sustainable use of water aligns with the project's goals to preserve the environment.



HYDROPONIC DIAGRAM | FIGURE 70

HYDROPONICS
soiless, water solution

Hydroponics is a type of hydroculture growing. The diagram left depicts a nutrient film technique (NFT), which is a system where plant roots are suspended directly into water with no growing medium. It is soiless. Water is pumped into the drip tray where plants absorb what they need. The unused water drains back into the reservoir where additional nutrients are added to maintain the proper mixture. This system reduces water use and is light weight.



AEROPONIC DIAGRAM | FIGURE 71

AEROPONICS
soiless, mist solution

Aeroponics is a variation of hydroponics. It utilizes the same principle of soiless, suspended growing. Plant roots are again suspended above a drip tray, or directly above the growing chamber but instead of applying a liquid to the roots, Aeroponics sprays a fine mist. This system is also light weight and reduces water use significantly compared to traditional growing techniques.

The 150 favorite pieces of American architecture, according to the public poll "America's Favorite Architecture" conducted by The American Institute of Architects (AIA) and Harris Interactive, are as follows. For more details on the winners, visit www.aia150.org.

Rank	Building	Architect
1	Empire State Building - New York City	William Lamb, Shreve, Lamb & Harmon
2	The White House - Washington, D.C.	James Hoban
3	Washington National Cathedral - Washington, D.C.	George F. Bodley and Henry Vaughan, FAIA
4	Thomas Jefferson Memorial - Washington D.C.	John Russell Pope, FAIA
5	Golden Gate Bridge - San Francisco	Irving F. Morrow and Gertrude C. Morrow
6	U.S. Capitol - Washington, D.C.	William Thornton, Benjamin Henry Latrobe, Charles Bulfinch, Thomas U. Walter FAIA, Montgomery C. Meigs
7	Lincoln Memorial - Washington, D.C.	Henry Bacon, FAIA
8	Biltmore Estate (Vanderbilt Residence) - Asheville, NC	Richard Morris Hunt, FAIA
9	Chrysler Building - New York City	William Van Alen, FAIA
10	Vietnam Veterans Memorial - Washington, D.C.	Maya Lin with Cooper-Lecky Partnership
11	St. Patrick's Cathedral - New York City	James Renwick, FAIA
12	Washington Monument - Washington, D.C.	Robert Mills
13	Grand Central Station - New York City	Reed and Stern; Warren and Wetmore
14	The Gateway Arch - St. Louis	Eero Saarinen, FAIA
15	Supreme Court of the United States - Washington, D.C.	Cass Gilbert, FAIA
16	St. Regis Hotel - New York City	Trowbridge & Livingston
17	Metropolitan Museum of Art – New York City	Calvert Vaux, FAIA; McKim, Mead & White; Richard Morris Hunt, FAIA; Kevin Roche, FAIA; John Dinkeloo, FAIA
18	Hotel Del Coronado - San Diego	James Reid, FAIA
19	World Trade Center - New York City	Minoru Yamasaki, FAIA; Antonio Brittiochi; Emery Roth & Sons
20	Brooklyn Bridge - New York City	John Augustus Roebling
21	Philadelphia City Hall - Philadelphia	John McArthur Jr., FAIA
22	Bellagio Hotel and Casino - Las Vegas	Deruyter Butler; Atlandia Design
23	Cathedral of St. John the Divine - New York City	Heins & La Farge; Ralph Adams Cram
24	Philadelphia Museum of Art - Philadelphia	Horace Trumbauer, Zantzinger, Borie, and Medary
25	Trinity Church - Boston	Henry Hobson Richardson, FAIA
26	Ahwahnee Hotel - Yosemite Valley, CA	Gilbert Stanley Underwood
27	Monticello - Charlottesville, VA	Thomas Jefferson
28	Library of Congress - Washington, D.C.	John L. Smithmeyer, FAIA and Paul J. Pelz, FAIA
29	Kaufmann Residence (Fallingwater) - Bear Run, PA	Frank Lloyd Wright
30	Taliesin - Spring Green, WI	Frank Lloyd Wright
31	Wrigley Field - Chicago	Zachary Taylor Davis
32	Wanamaker's Department Store - Philadelphia	Daniel Burnham, FAIA

AEROPONIC DIAGRAM | FIGURE 72

INFLUENTIAL ARCHITECTURE

People are busy. The average person goes about their days, minding their own problems and challenges without deeply questioning why some buildings are "better" than others.

That's why the public's choice for the top 150 architectural designs are meaningful. In 2006 and 2007, the American Institute of Architects (AIA) polled the general public for their favorite pieces of American Architecture. The results tell us, the designers, which projects are making an impact on them. By knowing which designs are influential, we can try to decipher why these projects do so. This type of inductive logic will help recreate/reinterpret the successful elements in order to create more meaningful architecture.

Relocated Roots' goal is to create a design that makes an impression - that does more than just exist as a building. It aims to serve as a symbol of values, just as these designs do. By inventorying why these designs are successful, it can attempt to incorporate the same principles.

Name: Empire State Building
Location: New York City, NY
Style: Art Deco
Year: 1931

Iconic Characteristics:
- Incredible construction speed
  1 floor per day, only 13.5 months total
- Tallest building in the world for ~40 years
- One of the Seven Wonders of the World
- Pop culture icon from films like King Kong and An Affair to Remember

Name: The White House
Location: Washington, DC
Style: Neoclassical
Year: 1800

Iconic Characteristics:
- The facade was originally created with lime based whitewash in 1798
- Was burned to the ground in 1814
- The north and south portico were added in 1824 and 1829, inspired by Ancient Greece
- Part of a 18th century rise in Neoclassicism

Name: Washington National Cathedral
Location: Washington, DC
Style: Gothic Revival
Year: 1990

Iconic Characteristics:
- Second-largest church building in the US
- Construction lasted 83 years, with carvings and other decorative work still ongoing
- The seat of the Episcopal Presiding Bishop
- Pop culture icon for its role in Presidential state funerals and inauguration prayers

Name: Fallingwater / Kauffman Residence
Location: Mill Run, PA
Style: Modern/Organic
Year: 1939

Iconic Characteristics:
- Listed by the AIA in 1991 as the all-time best work of American Architecture
- Listed as a National Historic Landmark
- Daring structural feats: cantilevered partly over a waterfall
- Seamlessly blends nature with design

Name: Willis Tower, formerly Sears Tower
Location: Chicago, IL
Style: Modern
Year: 1973

Iconic Characteristics:
- Tallest building in the world for ~25 years
- 110 stories tall, with a revolutionary bundled tube structural system
- First building to utilize the tube structure, has been highly influential in all skyscapers since
- The world's tallest steel-construction building

Name: Hearst Tower
Location: New York, NY
Style: Structural Expressionist
Year: 1990

Iconic Characteristics:
- First "green" high-rise office building in NYC
- Also NYC's first LEED Gold Skyscraper
- Heart Tower's base was building eighty years prior to its tower
- 85% of its structural steel contains recycled material, iconic example of diagrid structure

Name: Solomon R. Guggenheim Musem
Location: New York, NY
Style: Modern
Year: 1937

Iconic Characteristics:
- Uniform form: cylindrical with a wider top than base, a "temple of the spirit."
- Incredible atrium and skylight
- Controversial, rivals the artwork within?
- In sharp contrast to both the color and shape of surrounding Manhattan buildings

Name: Disney Concert Hall
Location: Los Angeles, CA
Style: Postmodern / Blobitecture
Year: 2003

Iconic Characteristics:
- Visually unique stainless steel skin
- Bold exterior form pushed boundaries of CAD software and construction methods
- Controversial cladding: the form and skin caused additional heating costs for neighbors
- Incredible acoustic performance

Name: Seattle Central Library
Location: Seattle, WA
Style: Postmodern
Year: 2004

Iconic Characteristics:
- Visually unique and crystalline geometry
- Iconic diagrid system with 11 stories of jagged glass skin
- Controversial form: confusing, impersonal, oppressive? Mixed critics.
- Design philsophy to allow function to dictate

THESIS RESEARCH SUMMARY

FINDINGS FROM AIA'S BEST ARCHITECTURE

These nine designs are picked among the list of the AIA's America's Favorite Architecture. They span over 200 years, through decades of progressing architectural styles, from all shapes and sizes.

Some designs from the list are old. The design is meaningful because it has become a part of the history of our country. They are embedded in our culture because they are an integral part of our functioning society and we have grown up learning about them.

Some designs from the list are meaningful because they accomplish the world's biggest, the city's first, and so on. The designs push the boundaries of what is possible and they make their impression on society because they achieved something incredible.

Some designs on the list are controversial. The work is both praised and criticized. This kind of notoriety can be good, especially if the resounding feedback is supportive. But it can also be bad, as design can stand out for the wrong reasons.

Some designs from the list are popular because they are shown/depicted on the media. Designs can be immortalized in books, tv shows, and news stations. Architectural design provides the setting and the background for stories to take place. This kind of exposure can help designs become household names and common knowledge.

But most of all, these designs are on the list of America's Favorite Architecture because they stand out. They do something different than the rest of the field and because of this, the work becomes a part of our culture and our values. By seeing our world progress and boundaries pushed, we too start to believe that we can do incredible things. Architecture can promote and advocate social change through its design by incorporating principles that promote the health and wellness of our communities. Inspiring others starts by creating inspiring architecture.

"We shape our buildings
Thereafter, they shape us.."

- Winston Churchill

SEATTLE PUBLIC LIBRARY INTERIOR | FIGURE 73

WHAT MAKES ICONIC ARCHITECTURE?

Architecture is the physical manifestation of a society's culture. It is a three-dimensional representation of the inhabiting people's values, ideals and principles. Because Architecture is an integral part of the built-environment, its symbolism can influence the public's perception of society as a whole. It can facilitate the transition of agriculture into an urban environment by promoting the good and demonstrating the incredible results. The thesis premise resolves around this belief: an idea can become implementation, and with exposure and powerful results, it assimilates into a culture.

To make a lasting impression on the architecture world, a project must some unusual element or original "thing" that it transforms into an extraordinary opportunity. Something atypical in a design must be capitalized upon in a unique and different way if it's going to stand out. In Vertical Harvest, the designers selected the site as their unique component. The building design is nestled into the side of an existing parking garage, and despite the unattractiveness of that situation, the project shines with eco-friendly solutions and beauty. In Via Verde, the site was also its unique component. Located in the Bronx New York, in a battered part of the city that needed hope, Via Verde introduces principles of community and holistic wellness. In the nine buildings pulled from the AIA's list, it's feats like height, form, sustainability and originality. By utilizing an unusual element and transforming it into the most interesting part of a design, a building is able to break the mold and stand out amid the field. Standing out makes a design noteworthy. An idea becomes implementation and if it's done well, standing out makes an impression.

The seemingly unattainable goals and success of a design also play a critical role in the perception of the project. Would we adore the Empire State Building if it didn't achieve the most incredible feats in structure and construction speed? Perhaps not to the same degree, but the other precedent studies also capitalize on the idea of bold ambitions and impressive success. In Vertical Harvest, they sought to produce 100,000 lbs. of produce annually. With a building footprint of only 1/10th of an acre, they are able to grow the same amount of food as 5 traditional acres. This is an astounding amount of food for so little space. With the ability to produce like this, that other communities are asking to replicate their model isn't surprising. Via Verde also mimics this ambition, but in a different way. It still pushes the boundary of its typology. With 250+ residential units, the design marks the next generation of affordable housing and sustainable living. Both of these cases achieve great things for their communities.

This idea of unattainable goals and impressive success also applies to the buildings from the AIA's list. A few examples could be: Fallingwater pushed the physical boundaries of cantilevering and its success attribute to the absolute beauty of the design. Gehry's Disney Concert Hall redefined architectural drafting by using CAD software for jet planes, not buildings. Willis/Sears tower created an original structural system that revolutionized the way we build skyscrapers today. The list of iconic architecture's accomplishes goes on and on, but the message is clear. Design must dream big.

This model of unusual element and bold ambitions armed with impressive success only comes to fruition if the design is intentional. Good architecture doesn't just happen. Pragmatic architecture that provides a solution for one particular client doesn't necessarily accomplish any world-changing actions, and yet, pragmatic architecture can still improve the lives of the community. Intentional architecture makes a lasting impression on people because it symbolizes hope, ingenuity and possibility of a stronger future. Relocated Roots attempts to tap into that intention to shift the mindset of the public towards meaningful communities and wellness. Intentional architecture is the implementation of an idea, which with exposure and powerful results, it assimilates into a culture.

BURJ KHALIFA, WORLD'S TALLEST BUILDING | FIGURE 74

PROJECT JUSTIFICATION

Urban agriculture is relatively new and formative concept. Because it hasn't been fully established as a "standard" within building design, the task of demonstrating why it's imperative to an increasingly urbanizing society is an appropriate one. If we as a society are to accept city farming as a viable method of producing food, the feasibility of this idea must be proven. The trend of urbanization creates an increase in population within already densely occupied places. This surge in city living decreases the available space for farming, while also increases the demand for food. City farming reduces pollution from vehicles transporating produce and creates a self-sustaining city model.

A comprehensive building design for a commercial farming facility is a challenging and appropriate final project for the thesis. Its design requires considerable attention because of its intense implications for Structure and MEP systems. The theoretical premise of initiating social change inspires a more creative, intentional, and technical solution than a majority of commercial architecture. The design of a futuristic farming facility will exhibit strong technical abilities in modeling, drafting, and simulations as well as personal ideals for environment and sustainability. A successful, atypical typology like an urban agriculture facility will convey creativity, resourcefulness and knowledge as well as a dedication to the discipline of architecture.

COMMUNITY-DRIVEN GROWING | FIGURE 75

Commercial farming is a viable business opportunity. Because of its foothold in monetary return, Relocated Roots is a calculated and smart development for the company's growth. Expending the funds for this project is a bold and leading-edge business opportunity for a company like Gotham Greens, whose mission is built on innovation and social influence. In order to create lasting impression, Architecture or design must be distinct and take advantage of an opportunity to create a significant impact. In order to achieve this, and prove this is a viable business move, funds must be spent.

Those funds will come from the existing multi-million dollar company, Gotham Greens. They are a real company, but a fictional client. Gotham Greens operates four commercial urban farms through NYC and Chicago, and a jump into the Cincinnati market would not be outlandish. The company generates money from investing, selling goods, and other means. Therefore, the design of Relocated Roots is not a frivolous pet-project, but a business opportunity, and all efforts to consider the cost and price will be made.

The business component of the design has a monetary return. Money and time goes into designing this urban farming facility which grows the crops and then sells them for a profit. The intangible value or latent return of the project comes from its impact on the local culture. How will it influence the social landscape of urban agriculture? To do this, the environment will need to be made in strong consideration for this project. Relocated Roots aims to influence the city's inhabitants, and it will do so, by reducing transportation of food to the city. This directly influences the amount of air pollution and reliance of fossil fuels. The project will also provide a more efficient and sustainable way of growing food, reducing the strain on the farmlands both far and nearby. By providing fresh produce grown directly in the city, the project will both help the environment and the Cincinnati Residents achieve better health and wellness.

I have always been interested in design that engages communities and does more for the people than just exist. Symbolic architecture, works like the Empire State Building and the Capitol in DC, symbolize values that we share as Americans: strength, order, pushing the boundaries of what's possible. It fascinates me that a building could influence the principles that people have. A modern urban agriculture facility that emphasizes social change could be one of those buildings. Its ability to influence the greater perception of agriculture is why this design is justified to be an appropriate final project. It begins by opening conversations and shifting the mindsets of people around me. Social change is a hard feat to accomplish all at once – it must start with one, grow to a few, and eventually could impact many.

ANCIENT AGRICULTURE

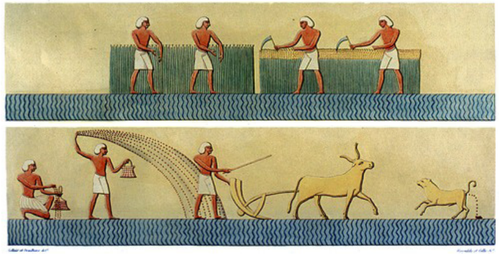
Agriculture is the active production of plants or animals in human created ecosystems. Because it is a cultural phenomenon, agricultural practices are inherited from one generation to another. This leads to its considerable variations across regions throughout time. Due to its varied and ambiguous beginnings, agriculture has no single, simple origin. It developed independently in many regions around the world with different and unique methods in each. The practice of clearing land, tilling soil, and domesticating crops was universal, and its use marked the first profound change in the relationship between modern humans and the environment.

Though humans evolved into our current form around 200,000 years ago, we did not begin to practice agriculture until about 15,000-10,000 years ago. The practice of settling down and growing food instead of hunting and gathering led to more food for less work. Agriculture in essence facilitated the establishment of the earliest civilizations - about 5,000 before the present.

Ancient civilizations grew early versions of many types of crops that still exist today: barley, wheat, flax, apples, plums and grapes are a few. They didn't plant just food: they grew cotton and hemp for clothing, coffee and coca for medicine.

With permanent settlements, ancient people were able to keep sheep, goats, cows and other animals. An ancestor of the modern day horse was likely domesticated by pastoral nomads around 6,000 years ago. Both the horse and the onager served critically in farming techniques as draft animals for plowing and digging irrigation canals.

Early farmers developed tools to ease the workload as well. Sickles made of flint and later iron and bronze were developed around the Roman Empire era. Watermills and dams helped grind the grains and cut the wheat easier. Large technological advances over the next couple thousand years made way for the farming we know today (Crawford n.d.).



HIEROGLYPHS IN RAMSES III TOMB | FIGURE 76

ANCIENT EGYPTIAN HIEROGLYPHS | FIGURE 77

MAJOR ADVANCES

Once humans had developed the foundations of practicing agriculture, the next 10,000 years were used to create technological advances to ease workloads and maximize production (Crawford n.d.).

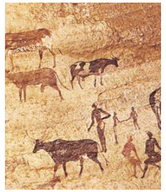


FIGURE 78

FIGURE 79

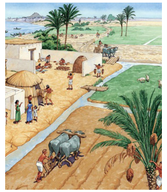


FIGURE 80

FIGURE 81

FIGURE 82

FIGURE 83

FIGURE 84

FIGURE 85

About 11,700 YA

Beginnings

The first people began practicing agriculture (plant and animal management) around the end of the Ice Age. Glaciers melted, and ecosystems worldwide reorganized.

About 8,000 YA

Farming Communities

With the ability to grow food, hunting and gathering practices were less utilized and people began to settle in permanent locations. This led to communities, trading, and irrigation.

About 5,000 YA

Civilizations

Armed with technology like the plow, sickles, and wagons, villages evolved into entire societies. People and animals were assigned with specific tasks and the workforce transformed.

200 bce to 600 ce

Culture

By Roman times, crop farming and domesticated animals were well established. With the abundance of food, people were able to pursue philosophy, science, art and culture.

600 to 1600 ce

Medieval Period

Despite the disease and famine that plagued Medieval times, farmers developed the systematic organization of acres to divide land and maximize tool use which they improved with metals.

1901 - 2000

The Twentieth Century

Agricultural technology developed more quickly in the 20th century than in all previous history. The invention of the internal combustion engine revolutionized farming as a new power source.

Today

Contemporary Agriculture

Today's farms look drastically different than they did even a century ago. Agriculture today is highly mechanized and controlled: synthetic fertilizers, pesticides and genetically modified foods.

About 15,000 YA

Urban Agriculture

While the future is still uncertain, agriculture has taken steps towards cultivation in skyscrapers. Advances like hydroponics and aeroponics have revolutionized growing systems.

FIGURE 78 PREHISTORIC CAVE ART
FIGURE 79 NEOLITHIC AGRICULTURE
FIGURE 80 MESOPOTAMIAN FARMING
FIGURE 81 ANCIENT ROMAN FARMING
FIGURE 82 MEDIEVAL LIFE
FIGURE 83 CHARLES JEFFREY TRACTOR
FIGURE 84 MODERN INDUSTRIAL FARM
FIGURE 85 EDITT TOWER, SINGAPORE

VERTICAL FARMING

Vertical farming is a relatively recent form of agriculture. The term, “vertical farming,” was coined by Ph.D professor Dickson D. Despommier in his book The Vertical Farm: Feeding the World in the 21st Century. His background in parasitology and environmental science drove his desire to change the way we grow food. He asked questions like, “what will the world be like in 2050?” and used his experience to dream up a system for food sustainability.

Using NYC as a model, he calculated how much food could be grown on all the rooftops in the city. Even then, only 2% of the population would be accounted for. He began to wonder “why plants couldn’t live on multiple levels, as human beings do.” And with that, the idea of vertical farming was born.

Despommier began to teach his students his ideas. He gave talks and wrote books about vertical farming and the good it could do for the environment. When his first book was published in 2010, there were no functioning vertical farms. By 2011, several had been built in England, Holland, Japan and Korea. Agriculture has been invented for thousands of years, and was practiced the same way right up to modern times. This new term, vertical farming, armed with alternative strategies and new technology will revolutionize our world.
In the USA today, vertical farms of all sizes function in Brooklyn, Queens, Chicago, Detroit, and Seattle, with more developing every year. The most population crop is baby salad greens, which at premium price, make the operation profitable. Once vertical farm technology has progressed enough, other crops will be adapted for indoor growth (Frazier, 2017).

Relocated Roots aims to build on the work of its vertical farming predecessors. It doesn’t necessarily reintroduce or reinvent the concepts and systems of vertical farming, but it does intend to utilize these modern farming techniques in a *socially-driven community design*. It will connect the commercial farming enterprise with the greater good of supporting a community. Relocated Roots will use the successful elements of other urban agricultural facilities to inform its design, but it will reinterpret the poetics of the facility in order to educate and unify a community. Relocated Roots will relate to similar projects throughout history in pragmatic ways: systems, scale and materiality. But it will build on the work of its predecessors in poetic ways: by emphasizing community, wellness and social activism.

VERTICAL FARMING | FIGURE 86

The historical context of agriculture is also its social context. Agriculture is why society developed. The ability to grow and control our food source allowed mankind to significantly reduce nomadic tendencies and establish permanent homes. Having settlements and reliable food sources meant our ancestors had additional time to spend developing culture and societies. With centuries of technological advances, we have become less and less involved in our food production. There is a social trend to purchase food at a grocery store from a faceless farmer hundreds of miles away. Relocated Roots recognizes the disconnection between us and our food source. It senses the longing of city dwellers to have a relationship with nature, and it believes that an urban farming facility could address both of these trends in an original way. It relates to social trends of stylish city living with its site selection and it shatters the barrier between people and farming by uniting the two right in the community.

SITE ANALYSIS

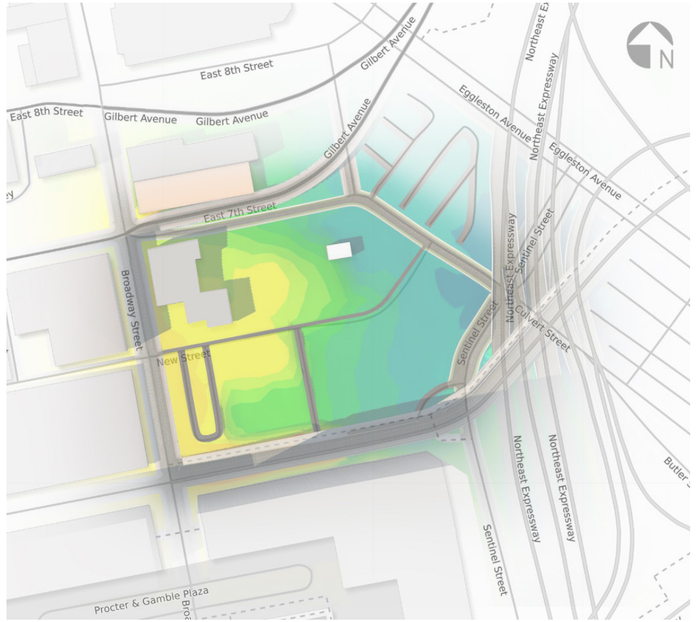
407 NEW ST, CINCINNATI, OHIO

407 NEW STREET BASE MAP | FIGURE 87

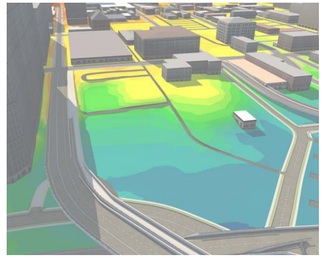
SITE EXTENTS | FIGURE 88

The site is comprised of many individual parcels combined into one 53,000 sf plat. The southern half exists as an at-grade parking lot, whereas the northern half is a two-story daycare. The blocks will be unified in the design of Relocated Roots and the access road between may be incorporated into the project. The project may also attempt to recover some of the lost parking in an additional structure or at grade parking.

TYPOGRAPHY



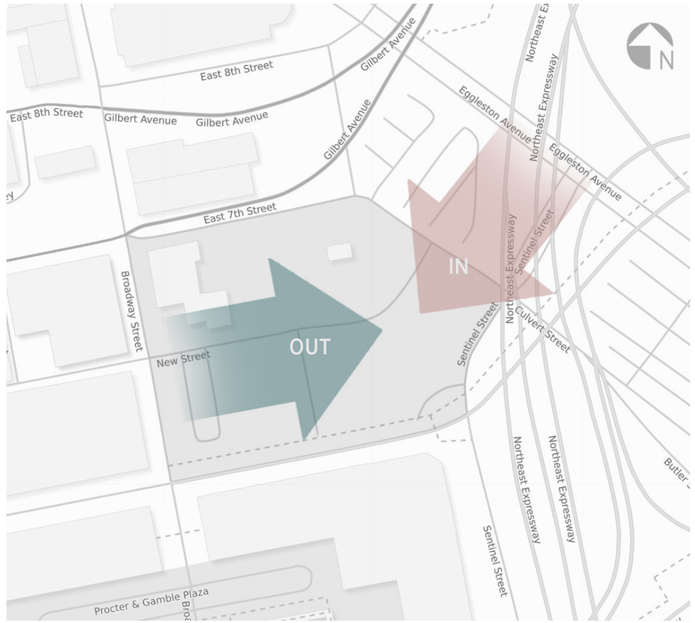
SITE CONTOURS COLORED | FIGURE 89



SITE CONTOURS | FIGURE 90

The site slopes down to the east in order to allow the interstate to pass over it unobstructed. This creates a change in elevation between the west and east ends of the design. The hill created will impact water drainage, grading and building positioning. The highest concentration of design massing will be in the middle of the slope in order to avoid both the pools of cold air at the bottom and the high winds at the top.

VIEWS



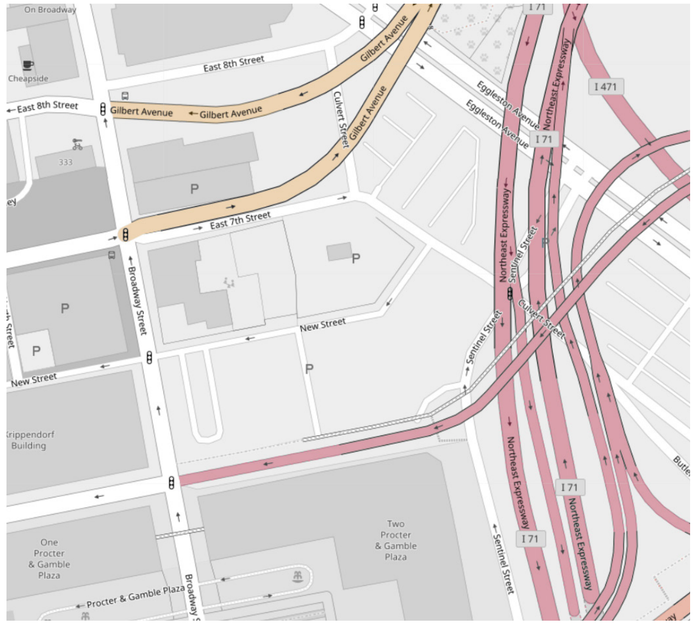
SITE VIEWS | FIGURE 91

The site exists on a hill. The upper or higher portion of the site sits to the west where the lower sinks below the interstate. This change in elevation creates opportunities for views into the site from the highway, and from the site to the hills.

Into the site:
The views into the site are the most important opportunity for Relocated Roots. The design is rooted in social impact, and by aligning itself with a major route for commuters, it maxmizes its exposure to the community. A design mass that is visually compelling from this angle will significantly impact its overall success.

From the site:
The design will sit atop the hill on the west side to maximize views to the east where there is a beautiful residential neighborhood.

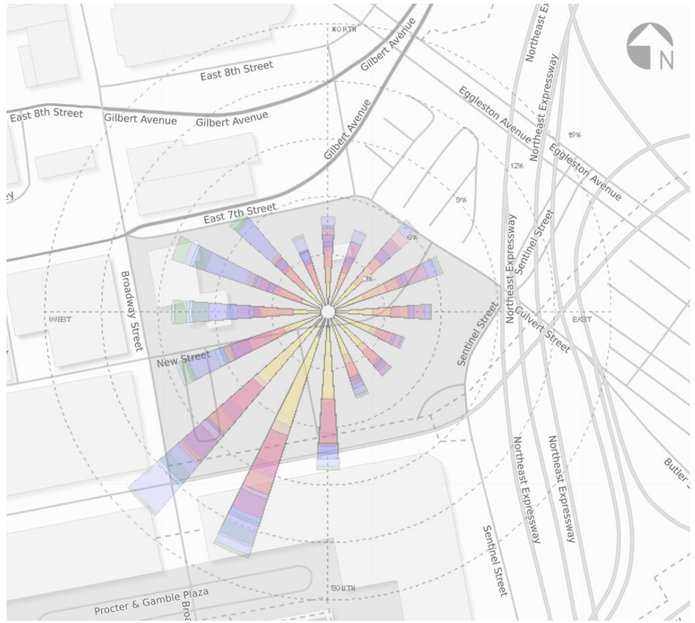
CIRCULATION



SITE CIRCULATION | FIGURE 92

Bounding the site on all four sides are means of vehicular traffic. Multiple interstates line the east of the site, and an exit ramp unloads directly to the south. Gilbert Avenue, which serves as an on/off ramp for Route 22 also borders the north of the sight. Additionally, the site is utilized solely by vehicles as it currently serves as a destination for vehicles to park. There are no pedestrian paths or destinations for a pedestrian to interact with on the site. There are several bus stops to the north and south of the site to accomodate public transportation. These stops are easily accessible and visible for passerbys to utilize if needed. Connecting the two Proctor & Gamble buildings, however, is a skywalk. The site lacks an element for pedestrians. The design of Relocated Roots will attempt to provide options for people to interact, as well as a nice place to wait for the bus.

WIND



SITE WIND | FIGURE 93

Winter Winds:
The design will place buffer spaces that have lower temperature requirements along the southwest of the building: closets, storage rooms, stairs, etc. The design will minimize openings facing the southwest as well, to reduce cold air infiltration.

Summer Winds:
The outdoor courtyard will be placed on the southwest of the design in order to capture the summer winds. Because Cincinnati has such humid summers, maximizing the natural ventilation through the space will be important to regulate the humidity. If the design incorporates shading devices, they will be louvered instead of solid, to prevent trapping hot air against the windows. Wind velocity increases with height above the ground, therefore, the main occupied spaces will be on the first floor.

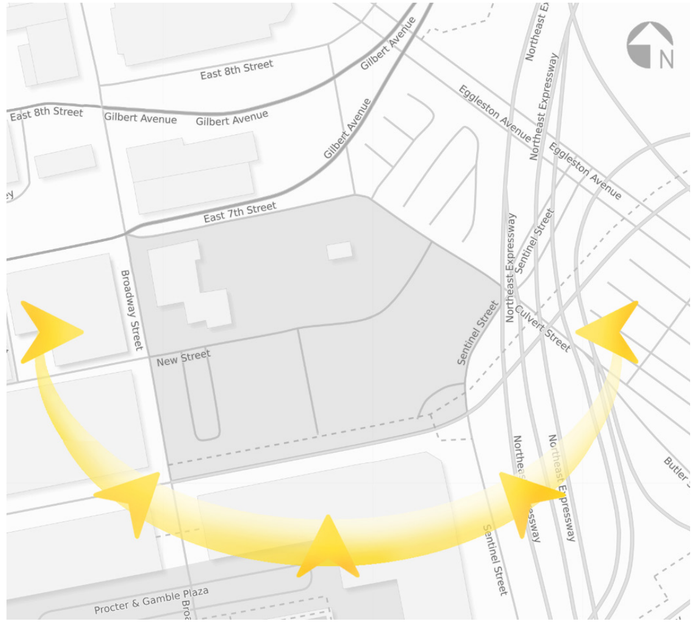
VEGETATION

SITE VEGETATION | FIGURE 94

The area surrounding 407 New Street has a limited amount of vegetation, mostly in the form of street lined sidewalks and as-needed landscaping. The two highest concentrations of vegetation exist directly on the site, and just to the southeast. The first is in support of the existing facility, a daycare. The kids use this playground during their outdoor activity time. The second is landscaping surrounding the highways. The city attempts to dress up the views as commuters travel.

There are some strategies for vegetation that would apply to this design. Because of Cincinnati's winds, the design will use evergreen vegetation to create windbreaks on the ground plane. It will also avoid trees directly on the south side of the building to allow for sunlight in the winter. The design will attempt to add vegetation to the city as well.

SUN STUDIES

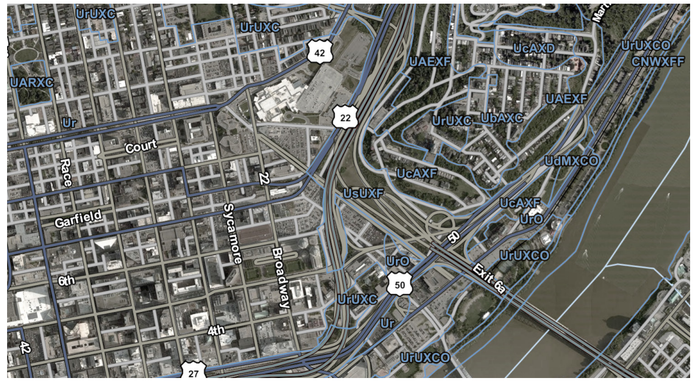


SITE SUN | FIGURE 95

Solar orientation is an important consideration in the design of Relocated Roots. The site's longest axis aligns east to west, which allows for plenty of sunshine for the plants, but also creates challenges for over heating. Therefore, the design will place spaces that benefit from solar heating along the south wall and align spaces where people are the primary occupant along the north and east walls. The south facade will utilize low solar heat gain glazing to minimize some of the summer sun, but the protection created by vegetation will also be incorporated into the landscaping.

The public plaza will also be located on the south of the building in order to maximize the vegetation. This exterior space could benefit from a patio or pergola design that would also create shade in the summertime, but allow sunlight in the winter.

SOILS



Map Unit	Complex	Type of Soil	Percent Slope	Flooded?
CNWXFF	Chagrin-Nelse-Wheeling		2 to 75	Frequently
UAEXF	Alfic Udarents-Eden		25 to 60	
UARXC	Alfic Udarents Martinsville		0 to 12	
UbAXC	Alfic Udarents	loamy substratum over bedrock	0 to 12	
UcAXD	Alfic Udarents	clayey substratum over bedrock	12 to 25	
UcAXF	Alfic Udarents	clayey substratum over bedrock	25 to 60	
UdMXCO	Mollic Udarents	loamy substratum over bedrock	0 to 12	Occasionally
Ur	-		-	
UrO	-		0 to 12	Occasionally
UrUXC	Udorthents complex		0 to 12	
UrUXCO	Udorthents complex		0 to 12	Occasionally
UsUXF	Udorthents complex		0 to 50	

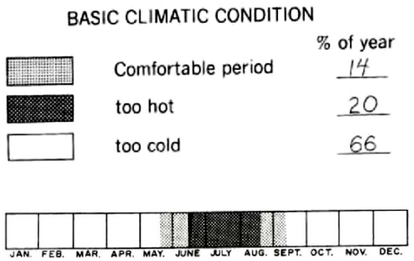
SITE SOILS | FIGURE 96

The soil report was generated from the USDA Natural Resources Conservation Service. The survey is broad and covers regional area surrounding the site instead of the immediate site.

Because of the Ohio River, much of the eastern soils are "clayey" and "loamy," where loamy is a sandy, silty soil mixture. This area is considered the riverbank and is prone to occasional flooding. Further inland is a collection of "Urban Land" soils. These include both paved and unpaved sites. The most variation occurs in the residential neighborhood to the north east of the thesis site.

Several soil samples are written as "over bedrock," which means the soil can support heavier and more robust designs due to its solid foundation. This is important for Relocated Roots as it is a structurally intense design.

CLIMATE



According to Heating, Cooling, Lighting: Sustainable Design Methods for Architects by Norbert Lechner, Cincinnati is located within Climate Region 3. Winters are somewhat milder than othe regions in the Midwest, but winter winds are still a significant concern. There is potential for solar energy because the sun shines more than 40% of the daylight hours. Summers are hot and humid. Precipitation is fairly uniform throughout the year, falling about 39 in (Lechner 2015). According to The National Weather Service, Cincinnati receives 9 inches of snowfall per year during the snowy period of the year (NWSC 2017).

Design Strategies

High Priority

- 1st Keep heat in and cold temperatures out in the winter
- 2nd Protect from the cold winter winds
- 3rd Let the winter sun in

Lower Priority

- 4th Keep hot temperatures out during the summer
- 5th Protect from the summer sun
- 6th Use natural ventilation for summer cooling

WINTER IN CINCINNATI | FIGURE 97

With the availability of winter sunshine, a design with plenty of glazing will benefit from the solar heat gain. Because Cincinnati exists in milder climate zone than other Midwestern regions, winters are more moderate. Summers, however, are hot and humid and a design would benefit from winds from the south west. Winter winds are very cold , so a vegetation buffer may help break or deflect some of the wind. Cincinnati also receives a moderate amount of snow. In 2017, the city received almost 9 inches. Due to this, Relocated Roots should utilize a sloped roof to reduce the effects of snow loads. To battle humidity, the design will avoid fountains and pools in the public plaza.

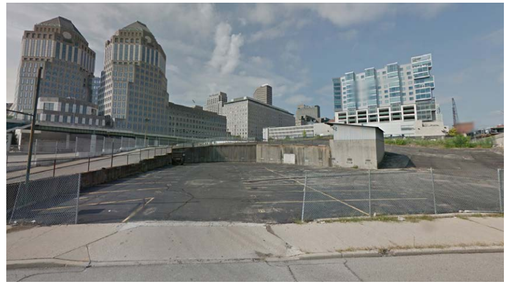
SUMMER IN CINCINNATI | FIGURE 98

SITE CHARACTER

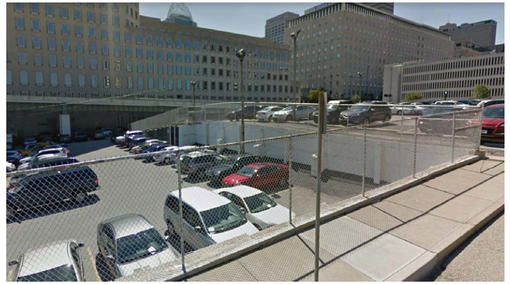
407 New Street is an underutilized site. It has the appearance of being run down and decrepit, which in a vibrant growing city, is a waste of its possibilities. The site is only five blocks from the Ohio River, but this concrete parking lot might as well exist anywhere in the US.

Its overall character appears lifeless and stagnant. The overwhelming amount of concrete is bad for the environment and shows the lack of thoughtful design. The site has no spirit and its clear that its being neglected. Weeds and litter are scattered carelessly throughout the site and chain link fences border nearly all the retaining walls. The site is hard, cold, and sends a message of “keep out!” and “move along quickly.”

While the existing site is dismal, there is a lot of potential for revitalization. The views to and from the site are spectacular. The sun shines bright throughout the year and its proximity to the Proctor & Gamble Headquarters means there will be a consistent stream of passersby, especially in nice weather. The community would benefit from a redesign of this site because its current state is so lacking in life and activity. A community-driven vertical farm would rejuvenate this space and enliven its spirit.

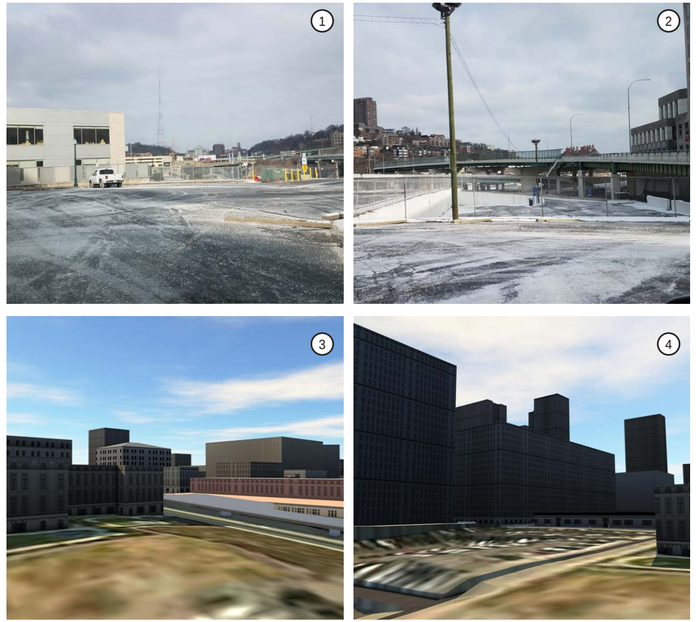


407 NEW STREET, LOOKING WEST | FIGURE 99



407 NEW STREET, LOOKING SOUTH | FIGURE 100

SITE RECONNAISSANCE



VIEW OF THE FOUR CORNERS | FIGURE 101

SITE CORNERS | FIGURE 102

The photogrid to the left depicts the views to the four corners of the site. The most compelling views are #1 and #2, which have lush trees and a beautiful view of the horizon. Views #3 and #4 are towards the city and capture the dramatic skyline and bustling life. The afternoon sun casts many shadows within the city, but the site itself receives plenty of sunshine. Over winter break, I am conducting an official site visit to Cincinnati.

PERFORMANCE CRITERIA

THERMAL PERFORMANCE

The first criteria to evaluate the project will be by its thermal performance. The interior temperatures, air velocities and humidities of each space will be measured and compared against optimal standards for assessment.

Throughout the design process, Autodesk Computational Fluid Dynamics (CFD) will be used to simulate the building's performance in specific conditions. At the conclusion of the project, a final set of simulations will be rendered in order to judge the final design. The final results of the CFD analysis will be transformed into visualization tools for analysis: graphs, charts, and thermal maps. This data will lead to conclusions about the success of the building performance in terms of massing, ventilation, solar orientation and materiality. This performance criteria is intended to test whether the final design reacts appropriately to various conditions, both hot and cold. To evaluate properly, a comfort index will serve as the optimal range, and the design's simulation will be evaluated at specific places using that metric. Any building clad entirely in glass is subject to intense thermal variability and the urban context creates an added level of complexity. Judging this design by its thermal performance is key method of evaluation because it will prove the feasibility of this typology in both scale and plant comfort.

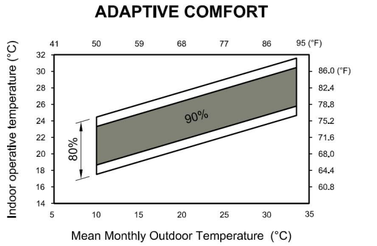
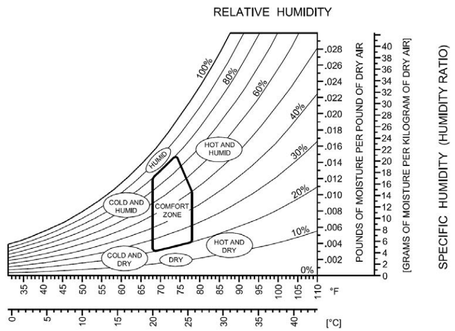


Figure 4.10 Under certain circumstances, people can be comfortable in conditions that fall outside the traditional comfort zone. In naturally ventilated buildings and where occupants have some control over their environment, the adaptive comfort zone increases along with the outdoor temperature. Operative temperature includes both air temperature and MRT.



THERMAL COMFORT ZONES | FIGURE 103

TOTAL FOOD PRODUCTION

The second criteria to evaluate the project will be by the amount of food produced by the design, in reference to the amount of space is required to grow it. The total food production will be measured in pounds, tons, or heads of leafy greens. The space required to grow it will be measured in square feet or acres.

In order to calculate how much food can be grown within the design, each floor plan will need to be fitted with an actual layout of growing trays. The total food production will be based on how many trays fit into the design multiplied by how much food each can produce. By placing growing tray products with specifications, the design will create an accurate measurement of the total food production. In addition to calculating how much food the design can produce, other precedent vertical farms will need to be researched in order to find an appropriate goal. Analyzing existing vertical farms to find a realistic production number is important for this criteria. By comparing and contrasting my crop production performance with other urban farms', I can evaluate whether the facility accomplishes its goal: – to grow more crops in more efficient space. And by inventoring other vertical farms' production, I can assess whether the facility sets a new standard for growing.

VERTICAL PLANTER | FIGURE 104

SPACE ALLOCATION

GOTHAM GREENS GREENHOUSES | FIGURE 105

Company: Gotham Greens
Year: 2011
Location: Greenpoint, Brooklyn

Square Footage: 15,000
Production: 100,000 lbs
Type: Rooftop Greenhouse

Unique Attributes:
First commercial scale greenhouse of its kind in the USA

Company: Gotham Greens
Year: 2013
Location: Gowanus, Brooklyn

Square Footage: 20,000
Production: 200,000 lbs
Type: Rooftop Greenhouse

Unique Attributes:
Fully integrated into the Whole Foods Supermarket below

Company: Gotham Greens
Year: 2015
Location: Hollis, Queens

Square Footage: 60,000
Production: 5 million heads / 500 tons / 900,000 lbs
Type: Rooftop Greenhouse

Unique Attributes:
Incorporates hydroponic technology

Company: Gotham Greens
Year: 2015
Location: Pullman, Chicago

Square Footage: 75,000
Production: 10 million heads of leafy greens and herbs
Type: Rooftop Greenhouse

Unique Attributes:
LEED Platinum Certified

Name	Small (sqft)	Average (sqft)	Large (sqft)	Percentage
Lobby	900	2,500	10,000	5%
Offices	900	2,500	10,000	5%
Mechanical Space	2,700	7,500	30,000	15%
Restaurant	1,260	3,500	14,000	7%
Exterior Courtyard	Site	Site	Site	0%
Classroom / Educational	1,440	4,000	16,000	8%
Greenhouse 1	2,700	7,500	30,000	15%
Greenhouse 2	2,700	7,500	30,000	15%
Greenhouse 3	2,700	7,500	30,000	15%
Greenhouse 4	2,700	7,500	30,000	15%
Total	18,000	50,000	200,000	100%

ALLOCATION CHART | FIGURE 106

18,000 sqft:		
4 Floors	=	4,500
5 Floors	=	3,600
6 Floors	=	3,000
50,000 sqft:		
4 Floors	=	12,500
5 Floors	=	10,000
6 Floors	=	8,333
200,000 sqft:		
4 Floors	=	50,000
5 Floors	=	40,000
6 Floors	=	33,333

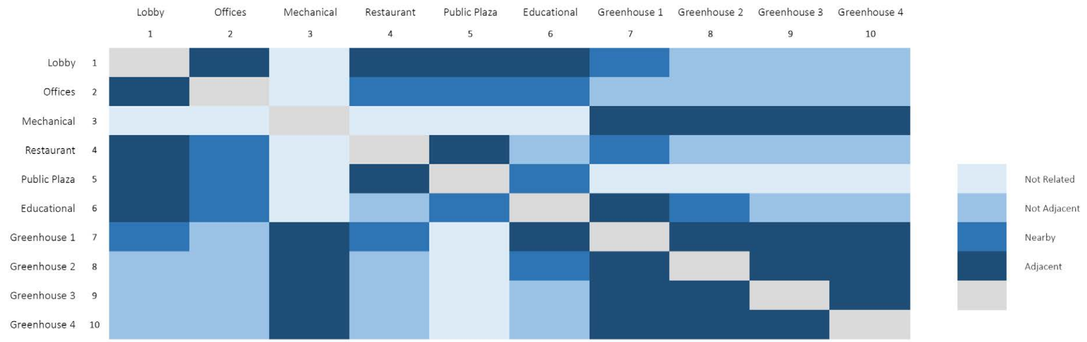
ALLOCATION CHART | FIGURE 107

SPACE ALLOCATION

Relocated Roots will incorporate several spaces in addition to its vertical farming greenhouses. Four projects by Gotham Greens are listed on the opposite page with specific information about each facilities' scale and food production. The client is already capable of generating these numbers, therefore, the above chart proposes the square footage requirements based on the preceding projects. Depending on the scale of the development, small, average, or large, Relocated Roots has some flexiblity in its space allocation due to its design intent for multiple floors.

This chart investigates how the total square footage will translate into a design with multiple stories. If the total site allows for ~53,000 sqft of development, a smaller footprint will be needed to accomodate elements like parking, plaza, and loading.

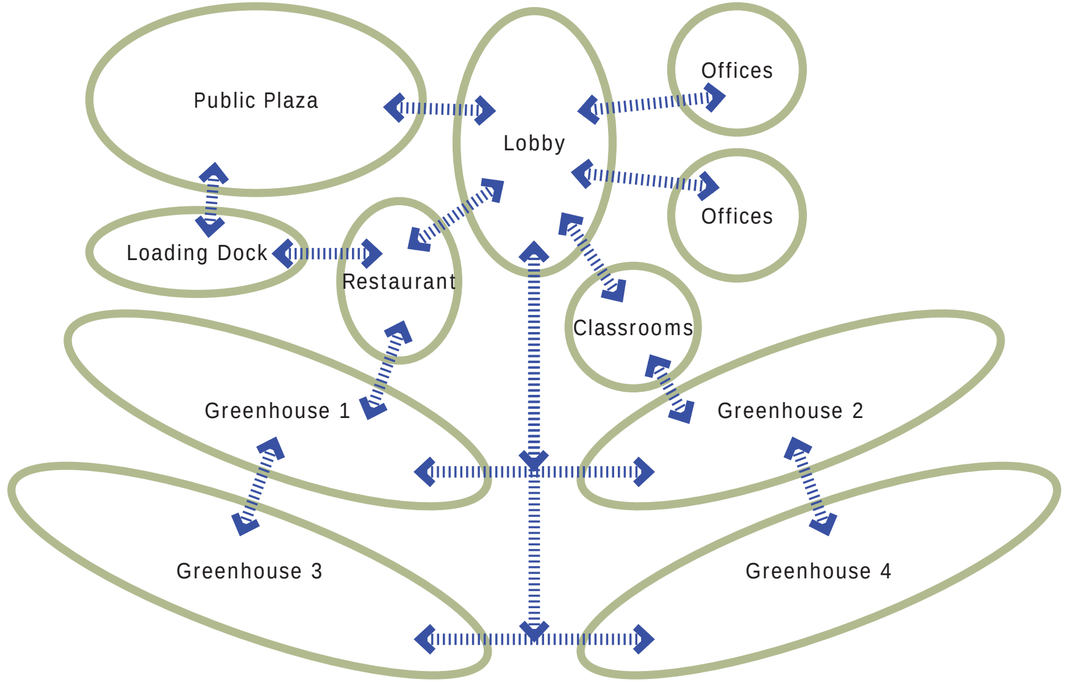
SPACE INTERACTION



INTERACTION MATRIX | FIGURE 108

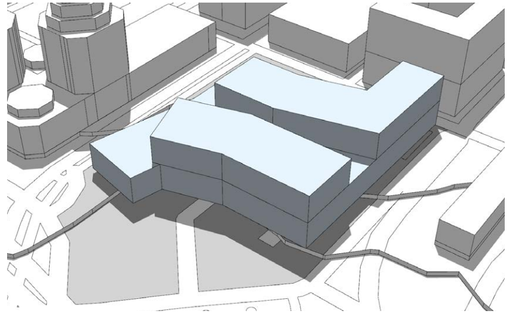
SPACE INTERACTION

The spaces within Relocated Roots will interact primarily through a centralized lobby. This hub will act as the primary location for visitors and users to connect to their destinations. The lobby will provide information and way finding tactics to assist people in finding their intended spaces. The building's other functions will branch off of the lobby in a circular, or radial pattern. Directly to the south will be the building's major element: the greenhouses. Aligning the greenhouses to the south of the lobby provides more opportunities for sunlight throughout the day as well as serving as a buffer between the interstate system and the building patrons' spaces. The restaurant and public plaza will align to the west of the lobby. This will allow for late afternoon sun during the farmer's market events in the summer. The loading dock will need direct interaction with the restaurant and greenhouses and aligns to the west as well.



INTERACTION DIAGRAM | FIGURE 109

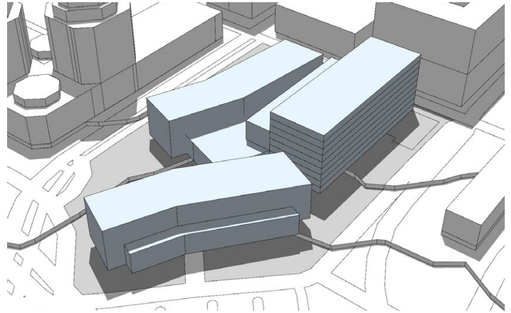
PROCESS DOCUMENTATION



MASSING OPTION | FIGURE 110

MASSING #1
interconnected masses

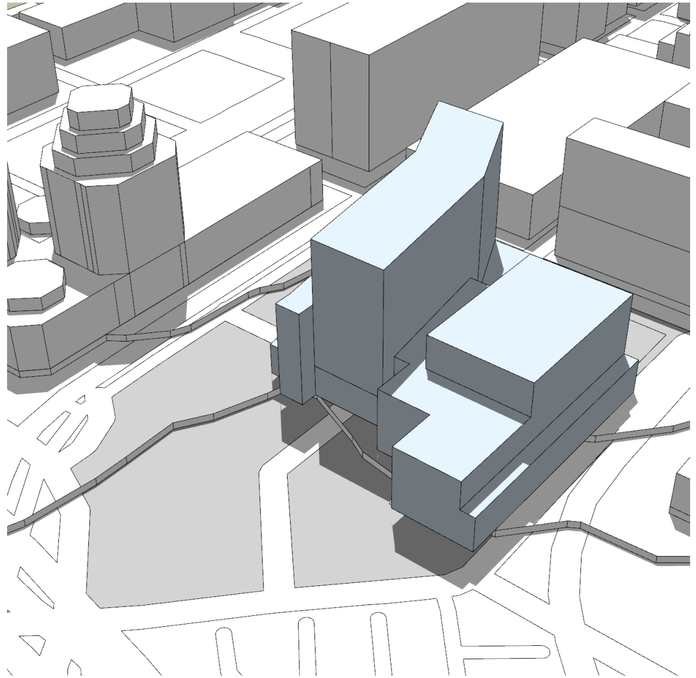
The first massing iterations utilized several design concepts that ultimately guided the final design solution. The first was the concept of interconnected masses. The building program required several functionally different spaces to be connected to allow for easy circulation, educational opportunities and transporation of materials.



MASSING OPTION | FIGURE 111

MASSING #2
consolidating building program

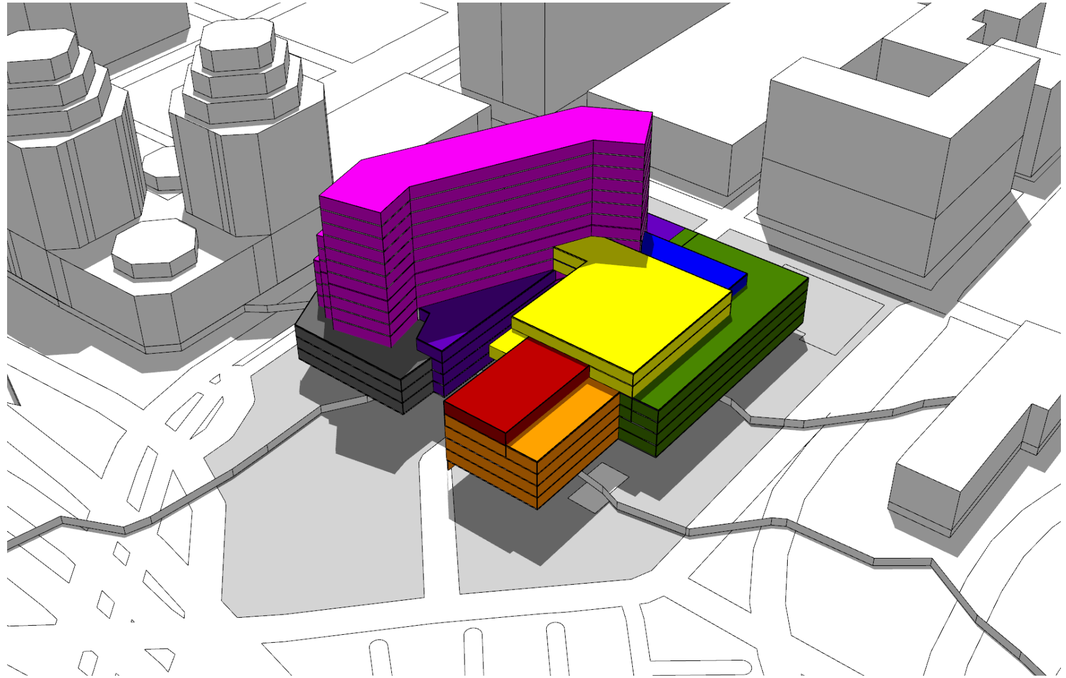
Because the building has significantly different uses throughout the program, it was important to centralize certain spaces to minimize travel paths. The concept of two separate masses was developed early and carried throughout the design process. Having a designated “urban agriculture” facility with separate but connected community-support spaces was an major design driver and ultimately gave considerable influence to the final design solution.



MASSING OPTION | FIGURE 112

MASSING #3
vertical tower

Integrating a vertical tower in relation to the research from the fall semester was also a consideration in the massing interations. Using the research findings' optimal form, site orientation and HVAC layout meant the vertical tower of Relocated Roots would thermally perform better than other designs simulated.



SPACE INTERACTION MASSING OPTION | FIGURE 113

RESTAURANT
LEASABLE SPACE
OFFICES
PARKING
CLASSROOMS
MECHANICAL
VERTICAL TOWER
WAREHOUSE

ADDITIONAL BUILDING SPACES

During the site visit to Cincinnati in December 2017, it became clear that additional spaces needed to be included in the building's program. These spaces included the need to maintain the existing site's function as a space for vehicular parking.

The downtown area of Cincinnati relies heavily on parking garages and on-grade lots to allow people to access buildings. More directly related to the site is a headquarters to the south which employs over 1,500 people. If building on the site were to take away from their access, the design would be a failure. Therefore, it became necessary to incorporate a parking garage/structure to fulfill that need.

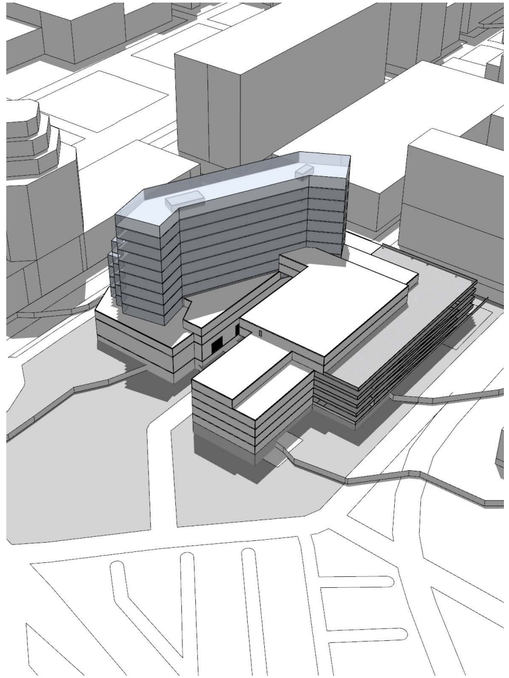
The schematic massing iterations attempted to incorporate these new building elements. It was important to the design to mass according to site considerations like building access and sunlight opportunities.

FIRST MAJOR DESIGN

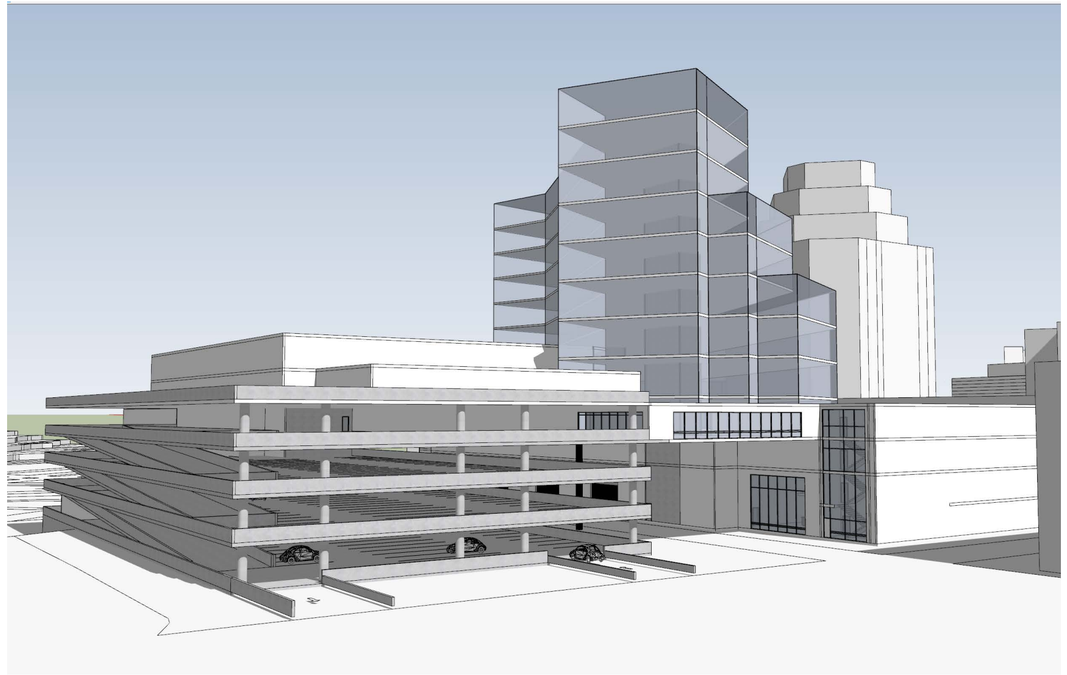
The major design iteration that preceded the final solution set the core concepts that guided the rest of the design process. This first formal iteration did not achieve the balance and visual continuity with the city as it was intended. The first design was built upon the idea of the vertical tower sitting on top of a warehouse podium, adjacent to the community support facility.

Ultimately, this arrangement of building forms did not convey the project goals as comprehensively as desired. Its initial floor planning and massing did not express a connection from the surrounding community to the farming and gardening spaces. The visual appearance was lop-sided and gave too much hierarchy to the vertical tower. There also wasn't enough built up behind the parking structure, which made the garage seem too prominent and control too much of the design's street facade.

Instead, the resulting final design solution built upon the principles founded in this early investigation. It uses the same concepts of interconnection, consolidated functions and balanced vertical tower to communicate a better integration of community into the agriculture facility.

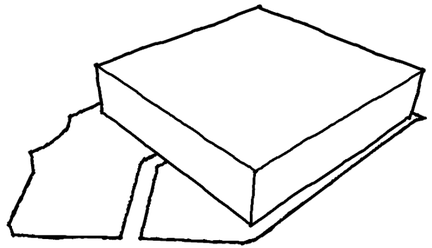


SCHEMATIC DESIGN ITERATION | FIGURE 114

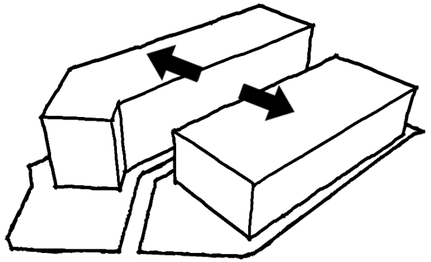


FIRST MAJOR ITERATION PERSPECTIVE | FIGURE 115

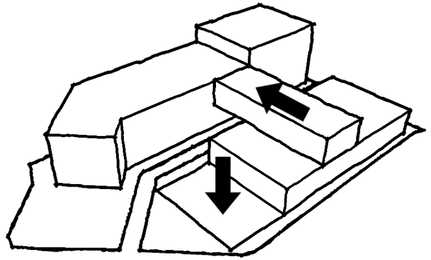
PROJECT SOLUTION DOCUMENTATION



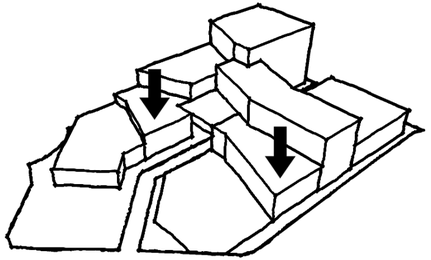
EXTRUSION OF THE BLOCK



SPLIT TO MAINTAIN ACCESS ROAD



CONNECT BUILDINGS AND CREATE OUTDOOR SPACE



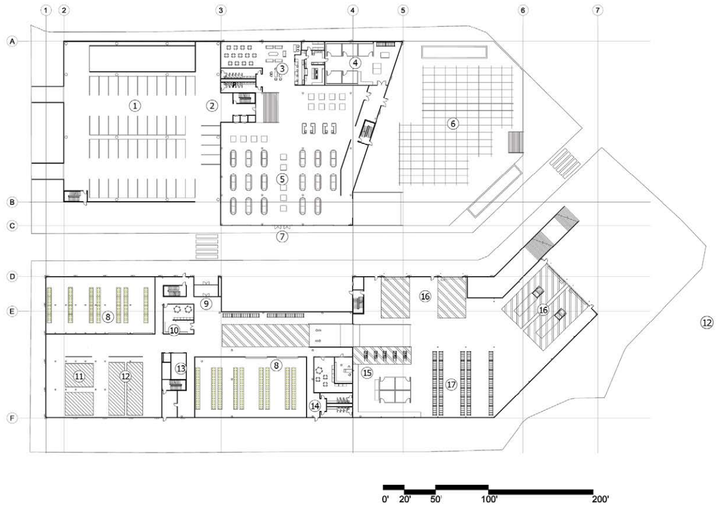
STEP DOWN ROOFS TO MIMIC TOPOGRAPHY

MAJOR DESIGN CONSIDERATIONS | FIGURE 116

FINAL DESIGN PERSPECTIVE | FIGURE 117

FLOOR PLANS

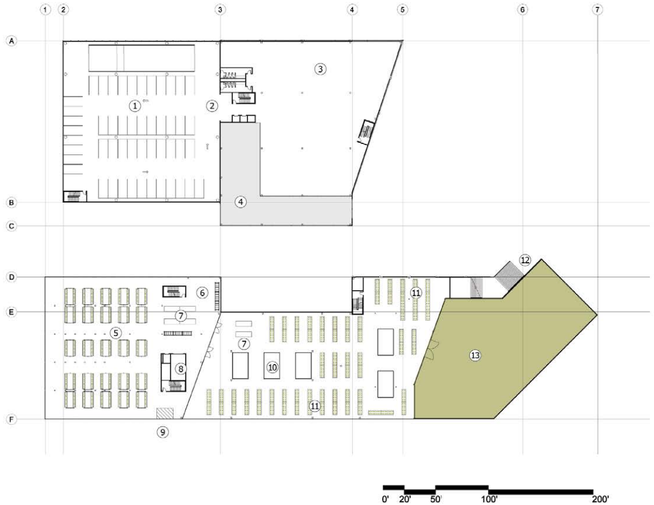
LEVEL ONE



1. Parking Garage (46 Spots)
2. Vehicular Visitors' Main Entry
3. Cafe/Bistro - Open to Public
4. Grocery Store Coolers + Storage
5. Grocery Store
6. Outdoor Patio: Farmer's Market
7. Pedestrian Main Entry
8. Light-Controlled Growing Area
9. Warehouse Employee Main Entry
10. Warehouse Employee Lockers
11. Mechanical Space Including Boiler, Chiller, HVAC
12. Aquaponic Water Treatment Tanks
13. Service Core Including Stair, Service Elevator and Passenger Elevator
14. Warehouse Employee Break Room, Main Office and Restrooms
15. Shipping, Processing and Storage Coolers
16. Delivery, Loading and Unloading
17. Material, Equipment and Pallet Storage

FINAL FLOOR PLAN DRAWING | FIGURE 118

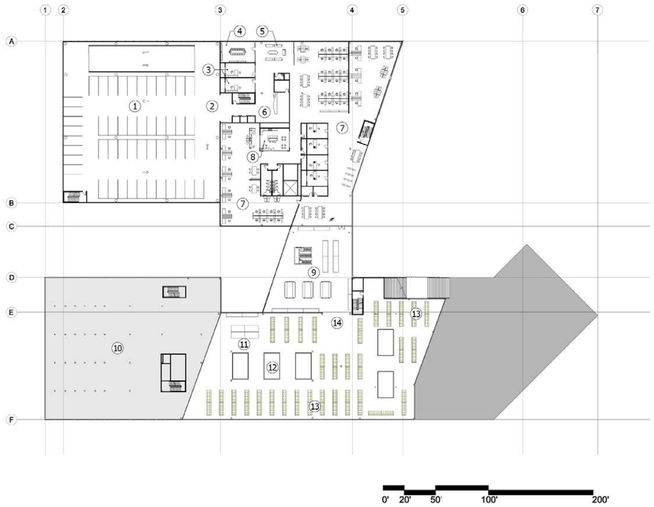
LEVEL TWO



1. Parking Garage (50 Spots)
2. Vehicular Visitors' Main Entry
3. Lease-able Space - Mixed Use
4. Open To Below
5. A-Go-Gro Vertical System (25 Units)
6. Material Storage
7. Planting Tray Processing
8. Service Core Including Stair, Service Elevator and Passenger Elevator
9. Air Handling Unit
10. Light Wells
11. Germination/Growing Space (71 Units)
12. Pedestrian Access To Roof
13. Public Green Roof

FINAL FLOOR PLAN DRAWING | FIGURE 119

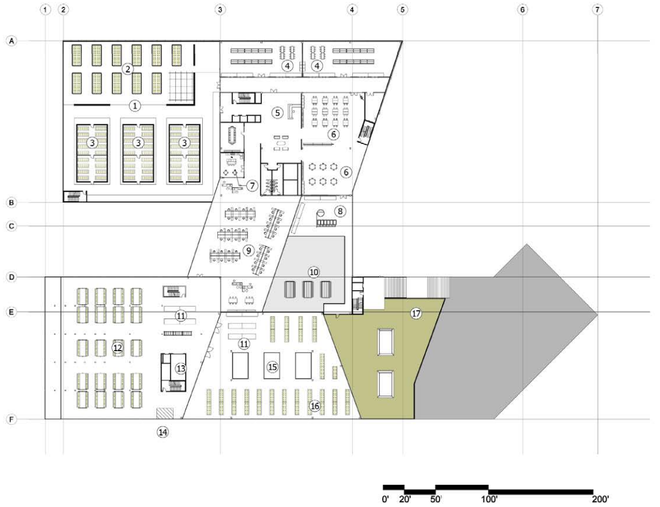
LEVEL THREE



1. Parking Garage (50 Spots)
2. Vehicular Visitors' Main Entry
3. Gotham Greens Administrator Offices
4. Conference Room
5. Waiting Area
6. Reception Desk and Coat Room
7. Gotham Green Open Office, Exec Offices
8. Employee Break Room
9. Research Laboratory
10. Open To Below
11. Plant Tray Processing
12. Light Wells
13. Germination/Growing Space (62 Units)
14. Laboratory Access to Growing Area

FINAL FLOOR PLAN DRAWING | FIGURE 120

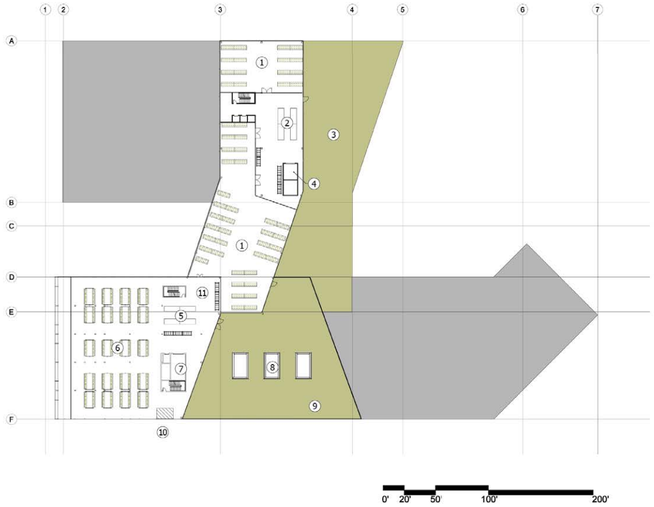
LEVEL FOUR



1. Community Rooftop Gardens
2. Assigned Planters (11 Units)
3. Community Rooftop Greenhouses
4. Hands-On Classroom
5. Urban Harvest Reception
6. Lecture/Traditional Classroom
7. Employee Break Room
8. Educational Mezzanine Level
9. Urban Harvest Open Office
10. Open To Below
11. Planting Tray Processing
12. A-Go-Gro Vertical System (20 Units)
13. Service Core Including Stair, Service Elevator and Passenger Elevator
14. Air Handling Unit
15. Light Wells
16. Germination/Growing Space (35 Units)
17. Public Green Roof

FINAL FLOOR PLAN DRAWING | FIGURE 121

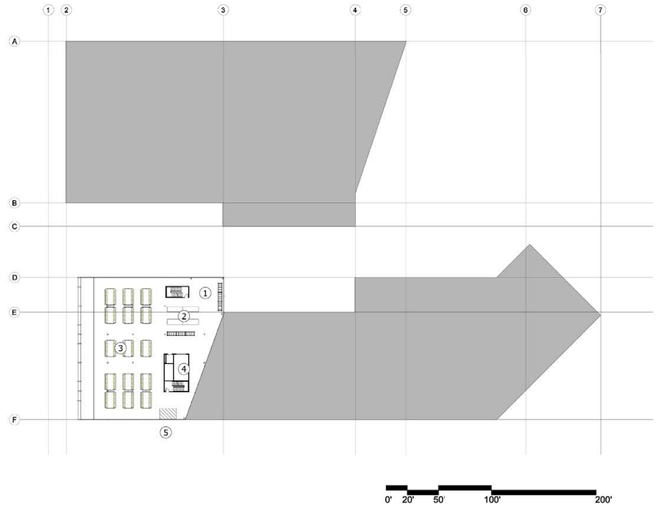
LEVEL FIVE + SIX



1. Germination/Growing Space (52 Total Units)
2. Planting Tray Processing/Workspace
3. Public Green Roof (Level 5)
4. Service Elevator for Levels 5-6
5. Planting Tray Processing
6. A-Go-Gro Vertical System (20 Units)
7. Service Core Including Stair, Service Elevator and Passenger Elevator
8. Light Wells
9. Public Green roof (Level 6)
10. Air Handling Unit
11. Material Storage

FINAL FLOOR PLAN DRAWING | FIGURE 122

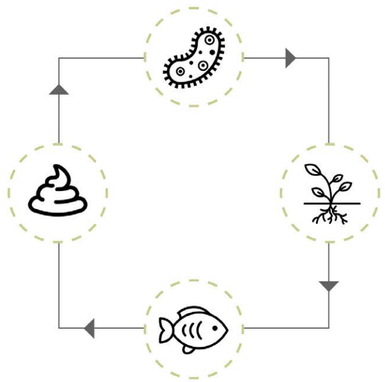
LEVEL EIGHT

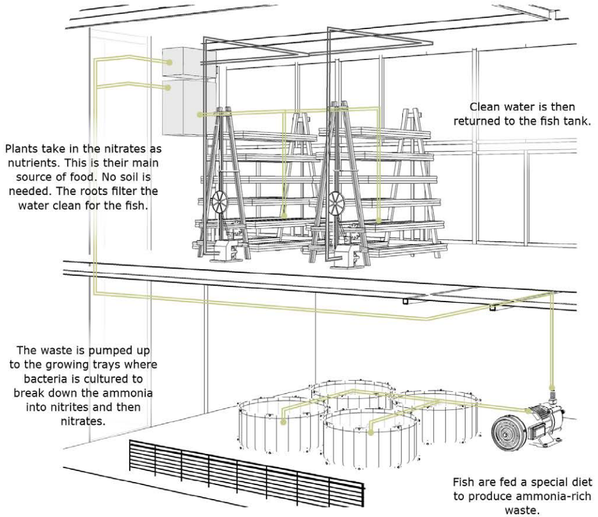


1. Material Storage
2. Planting Tray Processing
3. A-Go-Gro Vertical System (15 Units)
4. Service Core Including Stair, Service Elevator and Passenger Elevator
5. Air Handling Unit

FINAL FLOOR PLAN DRAWING | FIGURE 123

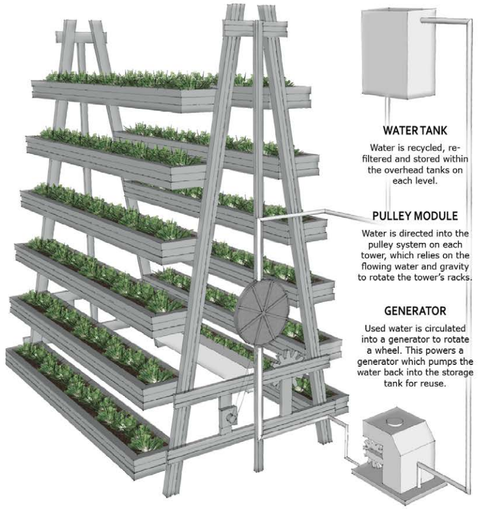
AQUAPONIC GROWING SYSTEM



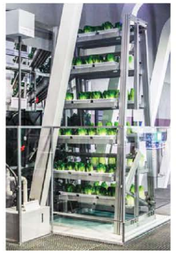


AQUAPONIC SYSTEM | FIGURE 124

A-GO-GRO VERTICAL SYSTEM



A-GO-GRO VERTICAL TOWER | FIGURE 125



An existing vertical farm called "Sky Green in Singapore provides an excellent precede design of a hydroponic vertical growing syste This A-shaped tower measures up to six mete tall and can grow up to 5x more crops than tl same amount of farmland. This system w selected for Relocated Roots due to its:

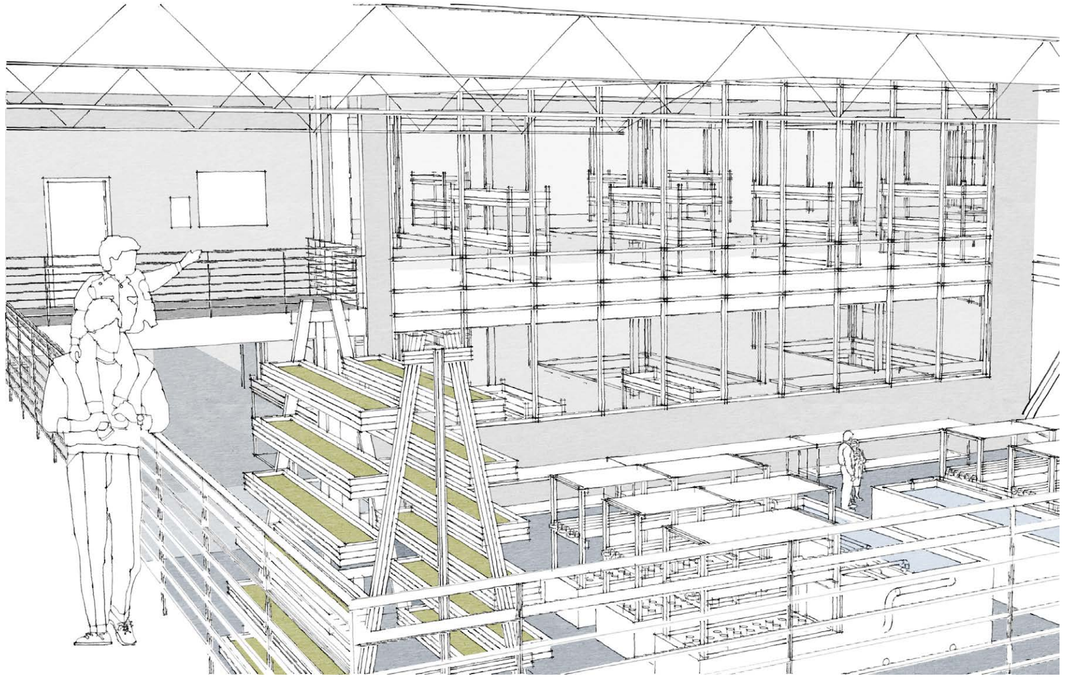
- modularity
- relatively simple installation
- ability to maintain individual units
- flexibility in size and cost
- rotating tray system based on gravity

According to Vertical Harvest, an urban agriculture facility in Wyoming, a traditional farm yields about 20,000 lbs of crop per acre per year. Although crop yield varies, this is a consistent figure.

Vertical farming uses the same footprint, but in a denser way. Vertical Harvest reports producing 100,000 lbs of food for only 1/10th of an acre - a land use of 1/50 of traditional farming.

According to the product specs, the Relocated Roots' growing system located within the multi-story greenhouse can produce the same amount of yield per 100 towers as an entire football field.

With 80 A-Go-Gro tower and 40,000 sf, the Relocated Roots' vertica farm can produce as mu yield as conventional farming, with a 15% decrease in footprint, ar 90% decrease in water



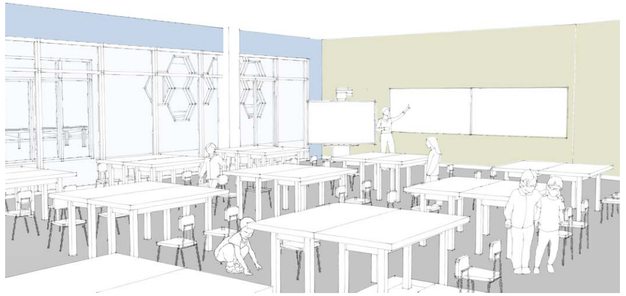
RESEARCH LABORATORY INTERIOR | FIGURE 126

COMMUNITY-FOCUSED

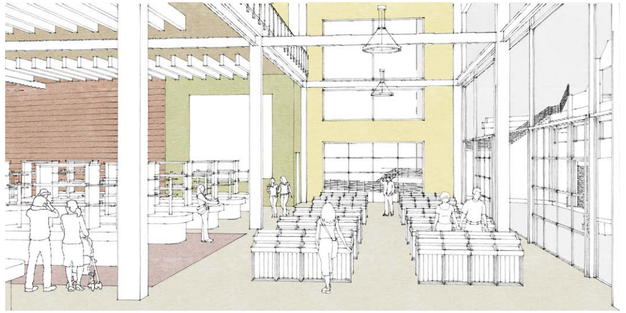
(Top Right) Education + Empowerment
On the fourth floor, there are spaces dedicated to an after-school program for K-12 students. Hands on activities and interactive learning teaches the science of botany, encourages patience and helps students practice responsibility. It also connects the urban youth to nature.

(Bottom Right) Community + Commitment
An organic grocery store is located on the ground floor and opens directly to an outdoor patio which hosts a seasonal farmer's market. This provides the community with fresh greens grown right in the facility. This commitment to locally grown food helps promote holistic wellness and a sense of ownership.

(Left) Innovation + Investment
The Cincinnati location will be the flagship facility for Gotham Greens. Part of the program is designated for plant science and botanical research. It is positioned adjacent to the education spaces to encourage visibility and create familiarity with a STEM discipline.



CLASSROOM INTERIOR | FIGURE 127



GROCERY STORE INTERIOR | FIGURE 128

COMMUNITY GARDENS | FIGURE 129

FARMER'S MARKET | FIGURE 130

IMPACTFUL DESIGN

Not only does Relocated Roots serve the community, but the design itself promotes a message. With a new typology and contemporary construction techniques, the design symbolizes both sustainability and a concern for the well-being of the environment.

There are several types of "community" spaces in the design. The public has access to the rooftop gardens and outdoor farmer's market. These spaces are intended to allow as many city dwellers the opportunity to connect to nature.

The design of the multi-story greenhouse also promotes a message by utilizing new materials and systems while functioning and producing as a successful farming facility. Architecture can promote change through careful and considerate design. By undertaking a struggling site, incorporating principles of sustainability and transforming the space into a place of community and growth, the design of Relocated Roots demonstrates that architecture can become a symbol of the future and act as a vehicle by which social change can travel.

MULTISTORY GREENHOUSE INTERIOR | FIGURE 131

PERFORMANCE ANALYSIS: SITE

SITE DESIGN SOLUTION

One of the biggest opportunities for the design is its site selection. Because community plays such a critical role in the premise, its location in the downtown neighborhood is carefully chosen. The site currently exists as an at-grade parking lot which primarily serves a headquarters building to the south. This parking lot is a void in the dense urban context.

The design incorporations that function into its design solution as to not take away from the community, but rather to maintain this asset and add more to the site. By integrating itself into the existing community, the design is more successful.

To the east of the site is the boundary of the downtown as it is constrained by several interstates. This system of highways provides a motivation for the design to maximize transparency and beauty. This visual exposure to commuters allows the design the opportunity to convey a message of sustainable urban farming simply by its adjacency. Relocated Roots intentionally cascades its roofs towards the interstates in order to create views into the facilities in the hope that by creating a visual connection to the design, commuters will gain familiarity with the typology.

SITE PLAN - NEIGHBORHOOD | FIGURE 132

The Proctor and Gamble headquarters is one block to the south of the site. This office building employs about 1,500 people, and the thesis design capitalizes on this with a parking garage, grocery store, and quick stop restaurant. Additionally, the P&G design has a popular public plaza which adds an additional level of engagement for Relocated Roots' visitors.

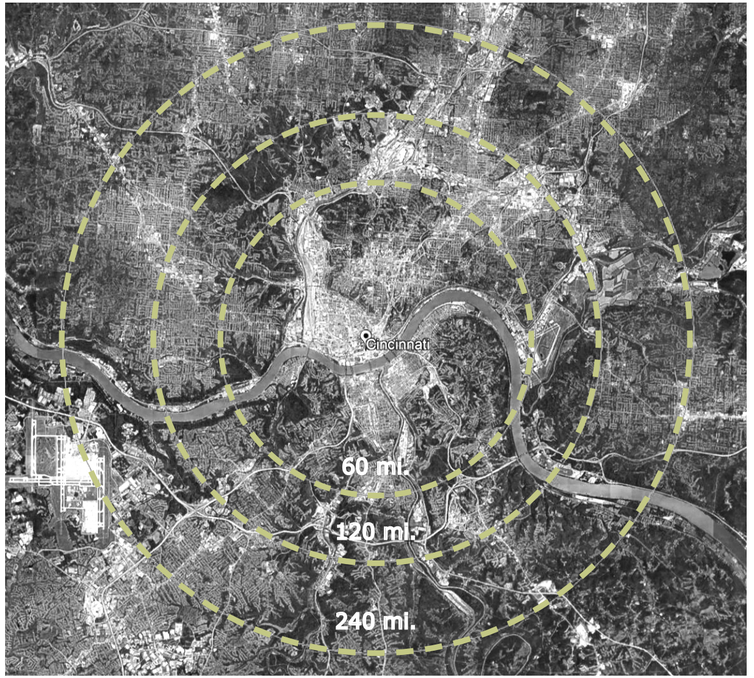
This region of downtown hosts many desirable destinations like historical museums, cultural sites, public parks and restaurants. There's also a theater for music and comedy. These places create incentive for people to visit and thus make the Relocated Roots' site more competitive. By its proximity to these places, the design gains valuable exposure.

Relocated Roots capitalizes on the downtown traffic by providing a destination with food and activity.

SITE PLAN - IMMEDIATE | FIGURE 133

RELOCATED ROOTS WITHIN SITE CONTEXT | FIGURE 134

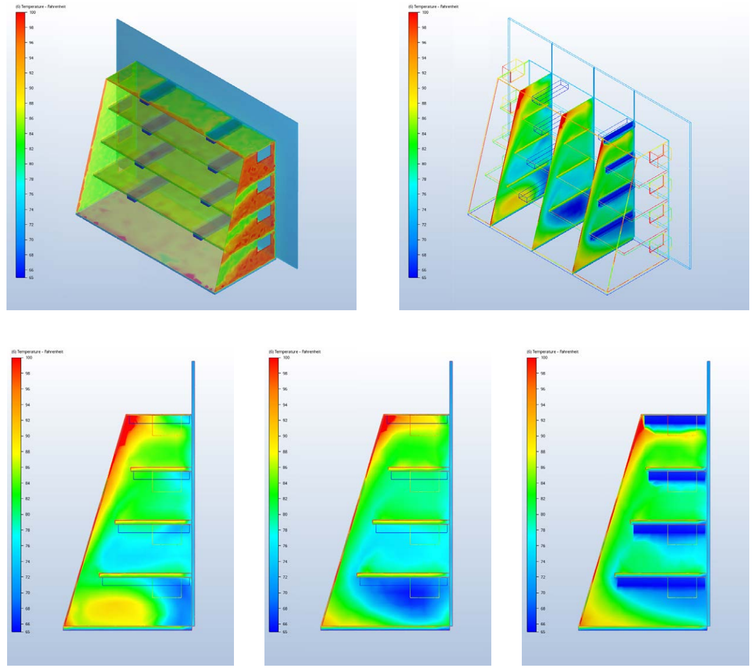
To the north and south of Relocated Roots' site exists entrance and exit ramps for interstate access. This adjacency allows the design to function as a "gateway" into the downtown district. The cascading roofs act as an introduction into the cavernous towers of the downtown, as well as creating visibility and sunlight opportunities into the facility. The hill opposite the highway is home to many Cincinnati residents. Along the highway pictured (left) is a pedestrian trail which connects the two zones.



DISTRIBUTION RANGE | FIGURE 135

The Relocated Roots mission is to provide fresh produce to residents amid the food desert surrounding Cincinnati. A food desert is a region where there is no access to locally grown food and challenging transportation access. To combat this, Relocated Roots follows a distribution network for deliveries to local grocery stores. Relocated Roots could reach communities within a 4 hour radius.

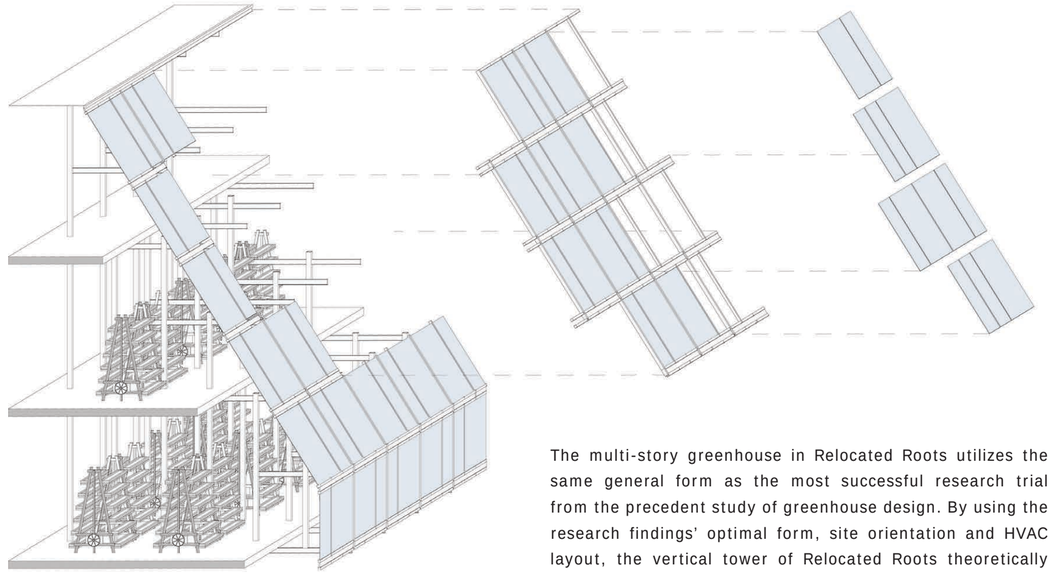
PERFORMANCE ANALYSIS: PRECEDENT RESEARCH



THERMAL SIMULATIONS | FIGURE 136

SIMULATION TRIALS

The second design, the passive solar greenhouse, performs better than the other designs based on its CFD simulation. While its sloped massing leads to a decreased amount of workable floor space, its current thermal evaluation outperforms the others in air circulation and solar heat gain. Its site orientation and massing protect against overexposure to sun and its staggered floors allow for air circulation without limiting floor-by-floor air control.



EXPLODED MULTISTORY GREENHOUSE | FIGURE 137

The multi-story greenhouse in Relocated Roots utilizes the same general form as the most successful research trial from the precedent study of greenhouse design. By using the research findings' optimal form, site orientation and HVAC layout, the vertical tower of Relocated Roots theoretically performs better than other designs simulated. It utilizes a ethylene tetrafluoroethylene (ETFE) panel system to glaze the exterior of the multi-story greenhouse and germination spaces due to its incredibly light weight and simple installation.

PERFORMANCE ANALYSIS: GOALS

LEED PLATINUM CERTIFICATION

Date: 5/7/2018

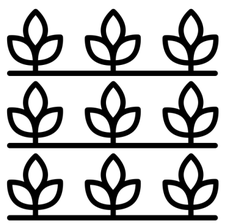
Y	?	N			
			Credit	Integrative Process	1
28	0	0	**Location and Transportation**		16
16			Credit	LEED for Neighborhood Development Location	16
			Credit	Sensitive Land Protection	1
			Credit	High Priority Site	2
5			Credit	Surrounding Density and Diverse Uses	5
5			Credit	Access to Quality Transit	5
1			Credit	Bicycle Facilities	1
1			Credit	Reduced Parking Footprint	1
			Credit	Green Vehicles	1
10	0	0	**Sustainable Sites**		10
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit	Site Assessment	1
2			Credit	Site Development - Protect or Restore Habitat	2
1			Credit	Open Space	1
3			Credit	Rainwater Management	3
2			Credit	Heat Island Reduction	2
1			Credit	Light Pollution Reduction	1
9	0	0	**Water Efficiency**		11
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
2			Credit	Outdoor Water Use Reduction	2
6			Credit	Indoor Water Use Reduction	6
			Credit	Cooling Tower Water Use	2
1			Credit	Water Metering	1
13	0	0	**Energy and Atmosphere**		33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
9			Credit	Optimize Energy Performance	18
1			Credit	Advanced Energy Metering	1
2			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
1			Credit	Green Power and Carbon Offsets	2
7	0	0	**Materials and Resources**		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
5			Credit	Building Life-Cycle Impact Reduction	5
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit	Construction and Demolition Waste Management	2
15	0	0	**Indoor Environmental Quality**		16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
			Credit	Construction Indoor Air Quality Management Plan	1
2			Credit	Indoor Air Quality Assessment	2
1			Credit	Thermal Comfort	1
2			Credit	Interior Lighting	2
3			Credit	Daylight	3
1			Credit	Quality Views	1
1			Credit	Acoustic Performance	1
6	0	0	**Innovation**		6
5			Credit	Innovation	5
1			Credit	LEED Accredited Professional	1
0	0	0	**Regional Priority**		4
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
88	0	0	**TOTALS**	Possible Points:	110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

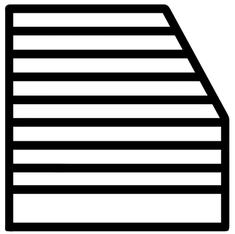
FINAL FLOOR PLAN DRAWING | FIGURE 138

FOOD PRODUCTION

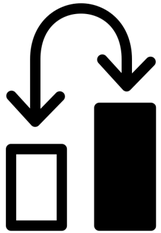
According to Vertical Harvest, an urban agriculture facility in Wyoming, a traditional farm yields about 20,000 lbs of crop per acre per year. Although crop yield varies, this is a consistent figure.



Vertical farming uses the same footprint, but in a denser way. Vertical Harvest reports producing 100,000 lbs of food for only 1/10th of an acre - a land use of 1/50 of traditional farming.



The Relocated Roots' vertical growing system located within the multi-story greenhouse can produce the same amount of yield per 100 towers as an entire football field.



With 80 A-Go-Gro towers and 40,000 sf, the Relocated Roots' vertical farm can produce as much yield as conventional farming, with a 15% decrease in footprint, and 90% decrease in water.

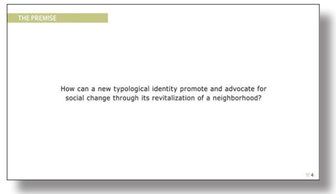
FINAL FLOOR PLAN DRAWING | FIGURE 139

DIGITAL PRESENTATION

1

2

3



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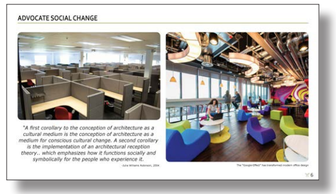

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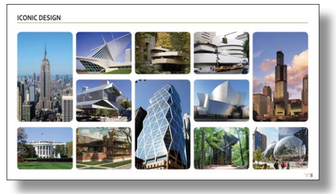

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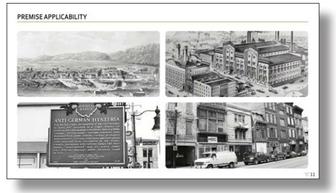

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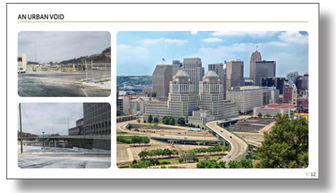

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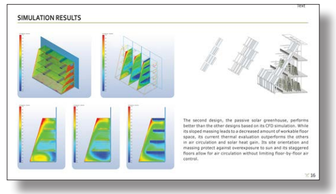

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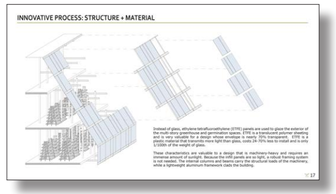

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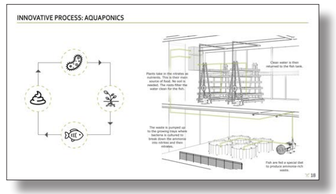
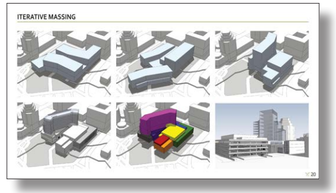


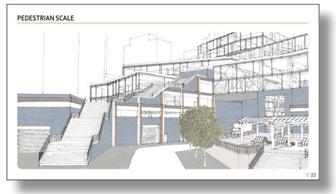
18


INNOVATIVE PROCESS: A-GO-GRO TOWER
An existing vertical form called "Sky Greens" in Singapore was used as a precedent for the design of a hydroponic vertical growing system. The system is modular, can be scaled to any size tall and can grow up to 5x more crops than the traditional method. This system was selected for Relocated Roots due to its:
• modularity
• relatively simple installation
• ability to maintain individual units
• ease of access for repair
• rotating tray system based on gravity
WATERTANK
PULLEY MODULE
GENERATOR
19


ITERATIVE MASSING
20


THE DESIGN
21


SITE PLANS
22


PEDESTRIAN SCALE
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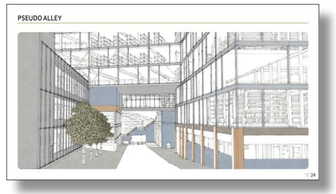
PSEUDO ALLEY
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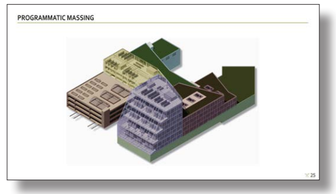
PROGRAMMATIC MASSING
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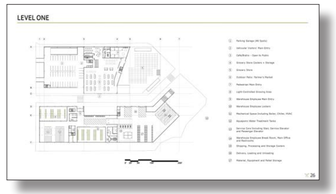
LEVEL ONE
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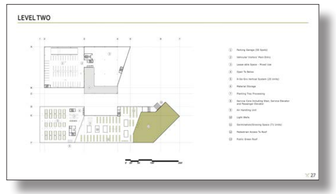
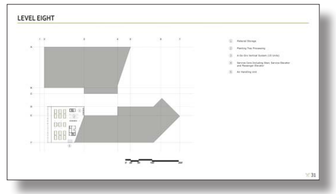
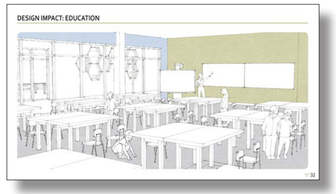

LEVEL TWO
27


LEVEL THREE
28

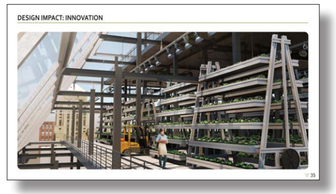

LEVEL FOUR
29


LEVEL FIVE + SIX
30


LEVEL EIGHT
31


DESIGN IMPACT: EDUCATION
32


DESIGN IMPACT: EMPOWERMENT
33


DESIGN IMPACT: INNOVATION
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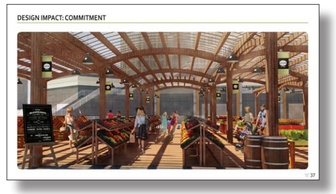
DESIGN IMPACT: COMMITMENT
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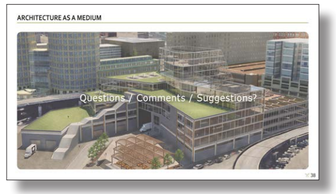
ARCHITECTURE AS A MEDIUM
Questions / Comments / Suggestions?
36

PROJECT INSTALLATION

PRESENTING AT THESIS EXHIBITION | FIGURE 140

MCKENZIE AWARD FINALISTS | FIGURE 141

FINAL MODEL | FIGURE 142

FINAL EXHIBIT IN FLAKOLL GALLERY | FIGURE 143

APPENDIX: REFERENCE LIST

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APPENDIX: STUDIO EXPERIENCE

Joan Vorderbruggen

ARCH 271:
Architectural Design I

- Teahouse
- Minneapolis Rowhouse

Adam Beck

ARCH 371:
Architectural Design III

- Red River Arts Center
- 262 Bowery

Darryl Booker

ARCH 272:
Architectural Design II

- Montessori School
- Pritzker Birdhouse
- Tiny House

David Crutchfield

ARCH 372:
Architectural Design IV

- Midwest Steel Institute
- Miami Breeze Hotel

Bakr Aly Ahmed

ARCH 471:
Architectural Design V

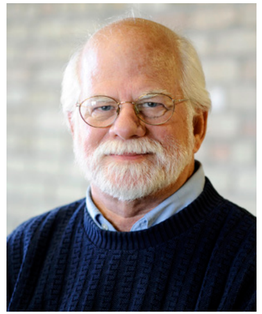
- Comprehensive Design High Rise

Ganapathy Mahalingam

ARCH 771: Advanced Architectural Design

ARCH 772:
Design Thesis

- Research Studio
- Thesis



Don Faulkner

ARCH 472:
Architectural Design VI

- 3D Modeling/Building Urban Design

APPENDIX: PERSONAL

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My best friend, Ben Gillis
My parents, Andrew and Irene Mills
And lastly my love, Dalton Ulmer

INTRODUCTION

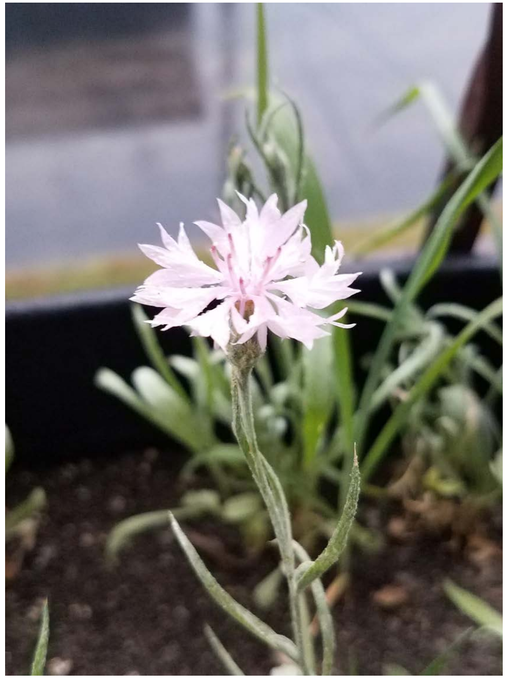
BACKGROUND

Oakes, North Dakota is a small farm town in the middle of nowhere. It is home to about 2,000 people, with only one working stoplight and two gas stations. I grew up in large metropolitan cities all over the continental United States, but it wasn't until my family landed in Oakes that I finally had a place I considered "home."

It was also in this little farm town that my mom and I shared a hobby for the first time. In the far left corner of our backyard, we laid out space for a small garden. It wasn't big or fancy as we didn't know much about gardening. But at the very least, we knew the basics: water, dirt, seeds and sun. We found an old shovel in the shed and that's all we needed to begin.

After weeks of watering and waiting, watering and waiting, we finally saw our plantings take shape. By the end of the summer we had grown a small harvest of herbs and green beans. We did this for a couple of years and we never got better or grew enough to any significance, but I'll never forget the feeling of satisfaction that we could do it.

In nostalgia of those times and in anticipation for this thesis, I attempted to do the same this last summer. Armed with several dishpans, a power drill and four bags of dirt, I planted a small variety of flowers and herbs. Here in the middle of North Fargo, on a third story balcony of a building by a bowling alley, I was able to grow plants in the city.

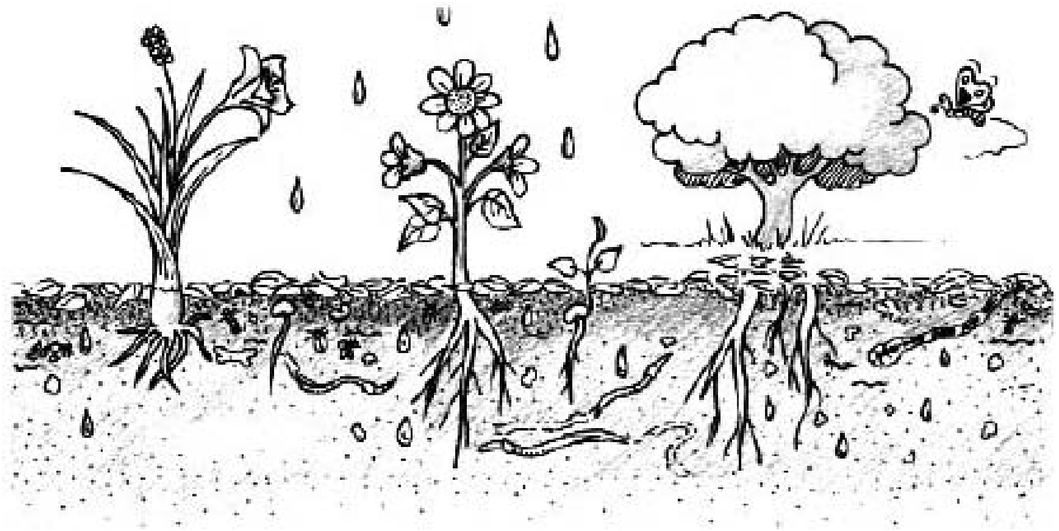


BALCONY GROWN BACHELOR BUTTON | FIGURE 2

The thesis concept revolves around this very idea. Can we as an increasingly urbanizing society successfully cultivate plants in the urban environment? And if so, how can architecture facilitate and guide that transition? What methods have proven architecture can promote and advocate social change with its design?

How can architecture promote and advocate for social change, while facilitating the integration of agriculture into the urban environment?

NARRATIVE



CITY SEEDLINGS | FIGURE 3

The way people are living is changing. People are increasingly relocating from rural areas to attractive and exciting urban communities. I myself moved away from my rural hometown to an urban city six years ago and will likely never live someplace that remote again. In 2015, The United Nations reported that 54% of the world's population resides in urban areas. That percentage is expected to grow to 66% by 2050 (2014). This influx leads to a limited amount of available space in cities with fewer green and open areas. This decrease in natural environments is a limitation surrounding our current mindset and consequently, city design for immense population growth can lead to a disconnection from the natural environment.

By implementing strategies to facilitate agriculture in the urban environment, we can provide a consistent supply of fresh produce while also providing healthy spaces for people to gather and socialize. This can be achieved by investigating how to increase crop yield while decreasing the farming footprint. Researching and implementing modern technologies like multi-story greenhouses, aquaponic/aeroponic/hydroponic systems, water management, waste-to-resource systems will also increase city farming's effectiveness. By growing taller and more efficiently, we can reduce the amount of space required for growing while yielding more food. As a profession dedicated to the public's health, safety, and welfare, Architects have a unique ability to plan and create spaces that influence the greater good. Our discipline can facilitate city farming by innovating our food source growth within our building designs. This idea of promoting social change, in conjunction with goals to revive our communities and heal our pollinators is a daunting but necessary task.

Although it is a relatively recent form of farming, urban agriculture is a modern phenomenon that is already happening. In order to address its integration into the urban environment, several strategies will need to be studied in order to provide accurate considerations in the design process: typological precedents, field research of existing conditions, and simulations of building performance. These strategies will lead the design to a comprehensive final solution that accomplishes the goals of the project.

Relocated Roots is focused on facilitating the integration of agriculture within the urban environment. It aims to redesign an underdeveloped site into a futuristic farming facility that incorporates principles of sustainable design, modern farm technology, as well as strengthens the sense of community. **This thesis is intended to demonstrate that architecture is a vehicle by which social change can travel and become instilled in society.**

OPPORTUNITIES

01. There's a longing for people living in densely developed cities to reconnect to farming and to nature.

Consistent contact with nature leads to many cognitive benefits. A study by psychologists from Carleton University have found a relationship between life satisfaction, improved moods and pro-environmental attitudes and their "subjective nature connectedness (Capaldi et al 2014)."

Another study by Kellert and Wilson suggests humans have spent all of our evolutionary history in nature, and have only relatively recently began to urbanize. This innate inclination to connect to nature is embedded in our modern psychology (1993). People's inherent desire to be close to the natural environment is an integral part of the thesis project. Integrating agriculture into the urban environment would have to be designed in such a way that commercial production wouldn't be obstructed by providing space for socialization.

02. Due to the urbanization of the US, growing more nutritious food closer to the city is necessary to support the increasing populations.

There's a growing demand for locally grown produce. People want fruit, veggies and herbs that are free from harmful chemicals. There's also a call for limiting transportation, leading to maximum freshness at delivery and less preservatives during transition. Bringing agriculture to the city shortens transportation mileages and lessens pollution for the environment. Farming vertically leads to higher quantities and qualities of food grown locally.

03. Rooftop gardens and farms provide many aesthetic benefits: recreational, leisure, relaxation as well as urban environmental benefits: absorbing heat, decreasing smog, reducing rain run-off.

According to the National Research Council of Canada (2002), rooftop gardens reduce energy demand through shading, evapotranspiration, and improved insulation values. They can reduce the heat island effect, which can reduce smog and problems with heat stress. They can also help improve storm water management by delaying run off and thus reducing strain on sewers and by filtering pollutants.

NOBLE ROT ROOFTOP GARDEN | FIGURE 4

RELEVANCE

Is agriculture a viable concept for an urban environment? The idea and pursuit of city farming is still relatively underdeveloped. Many cities in the United States have taken steps to facilitate its integration, but there's significant progress to be made. This concept is relevant to the field of architecture because of the growing concerns of population and urbanization. To sustain the growing population, we will need to produce more food. With the increased trend in city living, we can decrease transportation costs and pollution by integrating food production directly into the city.

The investigation of the feasibility of urban agriculture will begin during the ARCH 771: Advanced Architectural Research Studio. During this portion of the thesis, current design characteristics of single-story greenhouses will be inventoried, analyzed and built upon. This information will lead to the comprehensive design of a multi-story greenhouse facility as the final thesis typology.

PROJECT TYPOLOGY

STEDSANS ROOFTOP FARM | FIGURE 5

VERTICAL FARM
multi-story greenhouse

The primary typology of Relocated Roots is a vertical farm to grow fresh produce within the city.

GUATEQUE CO-WORKING SPACE | FIGURE 6

OFFICE + ADMIN
support spaces for the farm

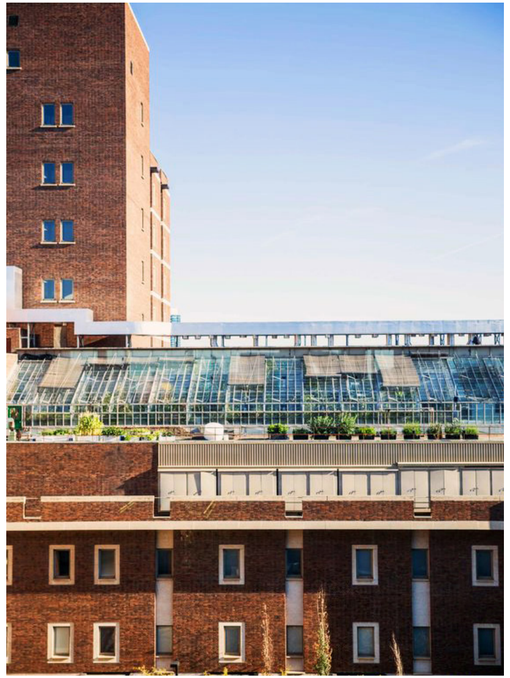
The secondary typology of the new building are offices and administrative support spaces.

Relocated Roots is a design thesis that integrates agriculture into the urban environment within an underutilized and vacant space: like a seed drifting in the wind that finds a home in an unlikely place. Downtown plot revivals are valuable and benefit the immediate community for many reasons.

Redesigning an untapped plot of land is like reintroducing a piece of the community's history. An urban plot is an excellent opportunity to be modernized and reconstructed into a functioning space. Incorporating the site's existing elements into a new design blends the city's history with contemporary ideas and architectural techniques.

Relocated Roots is a site revival architectural new build because of its project goals. The redesign of 407 New Street aims to facilitate the transition of farming into the city, promote social change by pushing boundaries, and reinvigorate a community with this new typology. In order to achieve this, a site in need must first be selected and analyzed.

An underutilized site provides an ideal opportunity to achieve these goals. An vacant parking lot will serve a community need but may have deteriorated and become a place of untapped potential. By adapting and reusing an underutilized urban site, Relocated Roots hopes to overcome the stigma and grow into a symbol of hope for the future.



UNIVERSITY OF ALBERTA GREENHOUSE | FIGURE 7

PRIMARY TYPOLOGY: VERTICAL FARM

Relocated Roots is designed to be a futuristic farming facility. It is classified as a “greenhouse” typology, which falls within the agricultural building category. It also will host office and administrative support spaces, and a market plaza - both of which fall within the commercial building category. Relocated Roots could be defined as a mixed-use building as there are multiple categories of building elements, although the primary typology is greenhouse.

The main difference between the Relocated Roots’ greenhouse and typical greenhouses are the number of stories or floors. Relocated Roots aims to provide a commercial-scale amount of produce, therefore it will need to maximize the footprint by growing up, not out. The design of multiple stories presents many challenges in terms of MEP, but fortunately the new build component of the design will attempt to address the design of these systems.

While a multi-story greenhouse isn’t exactly brand new, it also isn’t very common. The premise of Relocated Roots is to investigate how to make architecture a method of promoting and delivering social change. By using this up-and-coming typology, the project intends to capitalize on this formative idea to make a lasting impression.

ROMAINVILLE VERTICAL FARM | FIGURE 8

GOTHAM GREENS URBAN GREENHOUSE | FIGURE 9

VERTICAL HARVEST

VERTICAL HARVEST EXTERIOR | FIGURE 10

Vertical Harvest is an urban vertical farm designed by E/Ye Design. The three-story hydroponic farm is a start of the art greenhouse with multiple rooms acting as its individual micro-ecosystems. The greenhouse is designed to be well-regulated to maintain heat, moisture, uv light and carbon dioxide levels. While an unlikely place, the design actually fits into the side of an existing public parking garage. Vertical Harvest was built in Jackson, Wyoming and when the building opened in May of 2016, the design received national recognition for its innovative design and business model.

While it is small, the design is robust. Its footprint measures only 150 feet long by 30 feet wide, the 13,500 sq ft of downtown greenhouse produces 50,000 pounds of produce annually – and that's just its beginnings. Vertical Harvest expects to be producing 100,000 pounds of produce in under three years.

The building's footprint occupies only 1/10 of an acre and produces the amount of food traditionally grown on five acres worth of land. That's 1/50 of the fields required instead grown directly in the city next to a parking garage. In addition to its impressive yield, the greenhouse operates year-round in the harsh Wyoming climate. Its ability to accomplish this is in its building systems: The vertical farm uses a hydroponic growing method. This process speeds the growth of produce by almost double and requires no soil. It uses 90 percent less water than traditional growing methods because the water can be filtered and recirculated.

The designer of Vertical Harvest is an actual architect named, Nona Yehia. She and Penny McBride are co-founders who believe in the power of architecture to build communities. They recognized a lack of fresh produce in their community, a strain on transported goods, and a nearly impossible growing season. Despite these challenges, the founders fought for to put the project on the ground and immediately, the response was overwhelming. This idea of finding a community need and providing an architectural response is the premise behind Relocated Roots. **Vertical Harvest demonstrates that in even the harshest climates, the toughest budgets and sharpest critics, architecture can push the boundaries of design.**

"It started as a social mission," explained Nona and Penny.

"We wanted to make a difference in the community and inspire others to do the same."

A FUTURISTIC FARMING FACILITY

The design for Vertical Harvest responds to the environment very specifically. The grow lights used to supplement the natural sunlight require a certain amount of energy. But the particular kind they use creates net energy savings over the amount of energy needed to import produce. Their design also creates a significant reduction in the amount of land required to produce the same amount of yield while also using 90% less water. The design also integrate a highly-efficient heating system to supplement the cold Wyoming winters.

The greenhouse's primary function is to give back to its community through its high quality produce grown right in town. Prior to its build, Jackson would import almost all of its fresh produce from Mexico or California. Given the town's location among the mountains, there are times of the year where transportation trucks physically cannot deliver fresh produce to the local stores. Vertical Harvest closes the gap between imported food and locally grown food and by doing so, narrows the mindset that food must be grown far away and be delivered in. By allowing access for visitors to view the growing area without contaminating the crops, Vertical Harvest introduces the citizens to their food source and inspires locals to take back their food.

VERTICAL HARVEST CONCEPT RENDERING | FIGURE 11

NATURAL LIGHT
reduces energy use

The entire south facade is made of glazing to maximize the amount of sun for the plants. The engineers found the climate to serve minimal concern for solar heat gain.

SOUTH FACING GLAZING | FIGURE 12

HYDROPONIC
soil-less growing trays

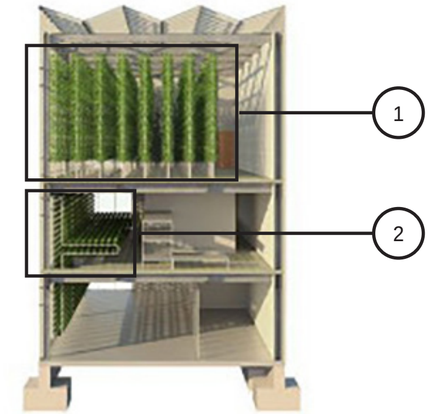
A concentrated liquid tailored to each species of plant - typically includes nitrogens, potassium and phosphate. The controlled environment optimizes flavor and nutrition.

GROWING TRAYS UNDER LED LIGHT | FIGURE 13

CONVEYOR SYSTEM | FIGURE 14

Vertical Harvest contributes its ability to yield so many crops to its unique stacked greenhouse design. The first two floors are assembled with each floor cultivating a different type of produce. A sophisticated conveyor belt design, or carousel system with growing trays, constantly revolves plants to maximize the natural south facing sunlight. The third floor operates a little bit differently. It is assembled similarly to a traditional single-story greenhouse, with a unique vertical tomato growing system. This original system has a steep learning curve, but once the systems become optimized, the vertical farm will provide so much good for the community.

VERTICAL TOMATO PLANT | FIGURE 15



TRANSVERSE SECTION | FIGURE 16

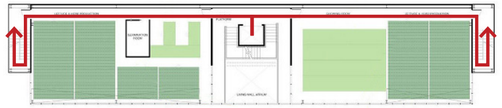
01. The vertical tomato growers This system provides the vertical support for tomatoes while minimizing space.

02. The conveyor belt / carousel This system rotates the crops evenly so sunlight is distribute equally.

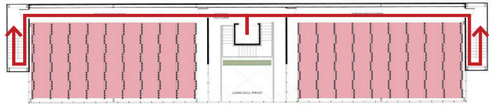
STEEL FRAMING | FIGURE 17

STRUCTURE

Vertical Harvest utilizes a light weight steel structural frame with concrete over metal decking floors. The frame is made of wide flange steel columns, girders and joists. The framing is joined together with moment connection plates and bolts. The exterior glazing is connected directly to the framework with no additional insulation. This likely mean the glazing is high performance in order to combat the winters. In all, the structure is simple and cost effect to maximize the budget.

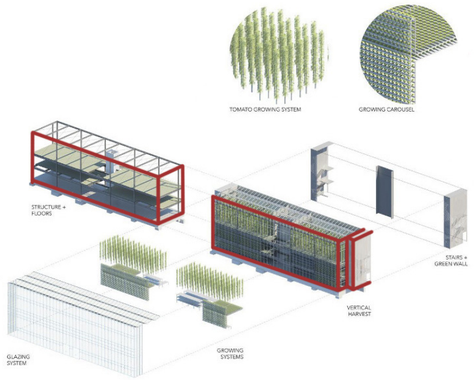


VH THIRD FLOOR | FIGURE 18



VH SECOND FLOOR | FIGURE 19

V FIRST FLOOR | FIGURE 20



SYSTEMS ASSEMBLY | FIGURE 21

CIRCULATION

Because Vertical Harvest has such a small footprint, its circulation must be simple and concise. There is a central “core” in the design with the main circulation to the rear. There is a three story atrium space in the center as well.

GEOMETRY

The geometry of the design is simple and concise as well. The building is a solid rectangle with no dramatic variations in form. The two stairwells on the ends provide a slight articulation in the form, but overall very sleek and neat.

BAY CONSTRUCTION | FIGURE 22

HIERARCHY

The simple form and structural framing of the design lends itself well to forming visual hierarchy. The thickest components are the columns, which aid in drawing the eye vertically along the farm. The next are the girders, which allude to the length of the building, and finally the thin curtain wall mullions which are a strong contrast.

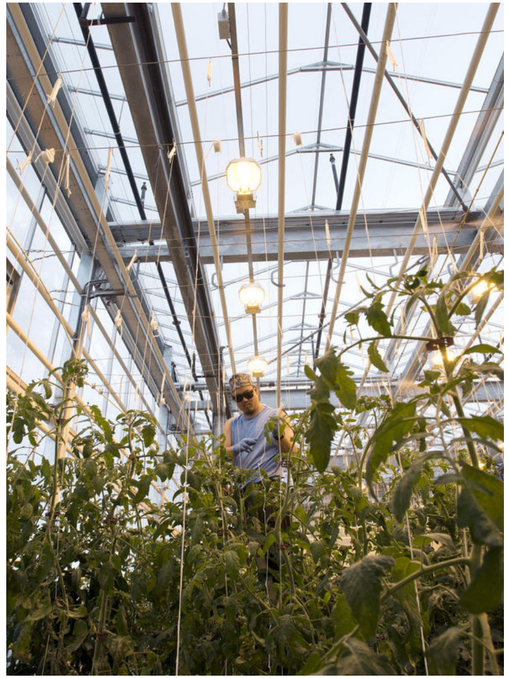
UNIT TO WHOLE

a modular approach

The entire south facade is made of the same repetitious pattern. At each bay, both regular and cross bracing is integrated to reduce deflection. This creates the appearance of a unit within a whole facade.

Vertical Harvest is similar to the other precedent studies in its intention to inspire social change. Just as the others attempt to, it strives to make a meaningful difference in the community and impact real lives with its actions. Its work showcases modern growing methods so much so that communities all over the country are interested in replicating their design. This system of inspiring others to make a difference is the goal of Relocated Roots. It differs however in that it's specifically an urban farm. The other precedent studies tackle the mission behind the theoretical premise, but this project specifically addresses both the typology and the underlying goal of the thesis. It provides actual precedent for designing this kind of typology. It gives insight into the quantitative numbers of vertical farm design. It lends knowledge into the structure, floor planning, and vertical system of greenhouses while also succeeding in its objective to inspire others.

Vertical Harvest contributes to the theoretical premise of the thesis in its typology and mission. It embodies both the goals of Relocated Roots and it provides knowledge of modern growing techniques. The design contributes insight into the structural and glazing requirements needed to provide for so many crops, and it adds a level of showmanship to the growing process. By designing a display of their systems, they're exhibiting great pride and care in their work. This translates into a meaningful example of urban agriculture.



THRIVING CROPS | FIGURE 23

GROWING TRAYS | FIGURE 24

The theoretical premise of Relocated Roots gains a new perspective of showmanship. A building's design can promote a message with a new typology and contemporary techniques, but it can also convey a sense of pride in the work with designs for displays. Perhaps the architecture can symbolize sustainability and the well-being of the environment and the interior design instills a sense of accomplishment in the successful integration of urban agriculture.

VIA VERDE - THE GREEN WAY

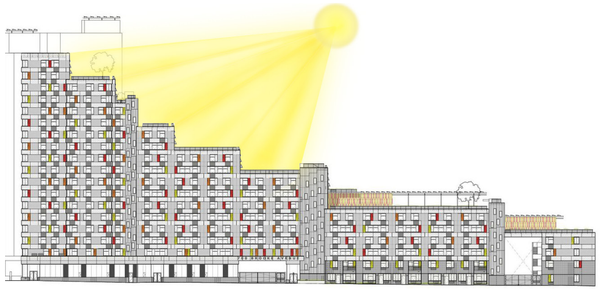
Via Verde means, “The Green Way.” And this sustainable residential development encompasses just that. This design by Dattner Architects and Grimshaw is located in the Bronx, New York and is revolutionary for its scale and affordability. Its design won the first juried design competition for affordable and sustainable housing in New York City. Totaling 300,000 sq feet, Via Verde hosts 222 apartments, a 20 story tower, 13 stories of mid-rise duplex apartments, and 2-4 story townhouses. It also has 3,700 sq meters of open space for green roofs, gardens and even a Christmas tree farm.

Via Verde marks a design commitment to create the next generation of affordable housing and sustainable living. This design was created to celebrate the integration of landscape and city, garden and urban building. It utilizes cross ventilation, solar shading, photo-voltaic canopies, high-efficiency mechanical systems, and energy conserving appliances and plumbing.

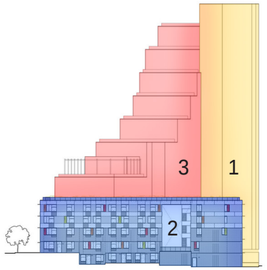
Dattner Architects and Grimshaw’s design is visionary. In a place where life can be bleak, they provide an architectural solution that substantially improves people’s lives. While the project may not make enough revenue to meet the affordability of the apartments, the tax deduction of rooftop gardens and financial support from the city allow hundreds of New Yorkers to live in a beautiful and healthy place. This case study shares with the others in that it makes a difference in people’s lives in an iconic and socially influential way.

While it shares in the values and mission of the other cases, Via Verde is typologically different from the thesis premise and other case studies. It primarily serves as a holistic residential complex for hundreds of people. It is included in the research study because it is a remarkably sustainable and environmentally conscientious design. It captures the integration of the land into the urban environment while invigorating a community. It embodies the goals of Relocated Roots’ premise despite its differing typology.

VIA VERDE EXTERIOR PERSPECTIVE | FIGURE 25



WEST ELEVATION | FIGURE 26



SOUTH ELEVATION | FIGURE 27

NATURAL LIGHT

Via Verde maximizes natural light for its rooftop terraces and units. The rooftop gardens and private patio spaces are stepped down in order to maximize the angle of sunshine. This decision creates a pleasing visual rhythm in the overall form of the building while also providing an appropriate consideration for the gardens. The photo-voltaic panels are also placed against these “steps.” By placing them against the walls, the PV panels are not obstructing the views or beauty of the design. The units are also able to receive plenty of natural light due to its simple form not casting shadows.

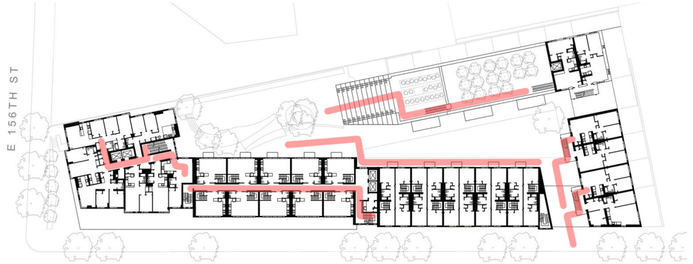
MASSING

There are three main masses within the design for Via Verde. The first is referred to as the “tower.” This space is the tallest and most rigid in form of the three masses. It houses the bulk of the affordable units. The next is the duplex apartments. It is the shortest of the masses and has the most community oriented rooftop space. The last are the terraced units. This mass is the most visually interesting part of the design and it connects the two drastically different heights of the other two masses. By stepping the design down using this mass, the entire building appears unified and intentional.

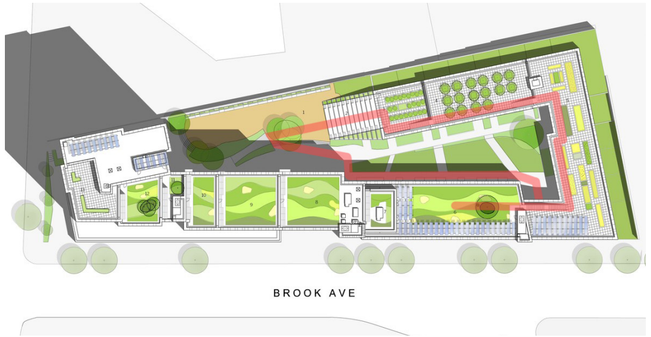
CIRCULATION

Circulation through Via Verde is very simple and straightforward. Their floor plans for units follow a double-loaded corridor pattern in a linear arrangement. The units are square and modular. Their outdoor circulation is also linear. Each exterior space is connected by one staircase and leads up the rooftops in a stair formation. This allows users to “walk” up the city via the rooftops, with gorgeous views to the city.

VIEW FROM ROOF | FIGURE 28



TYPICAL FLOOR PLAN | FIGURE 29



SITE PLAN | FIGURE 30

COURTYARD PERSPECTIVE | FIGURE 31

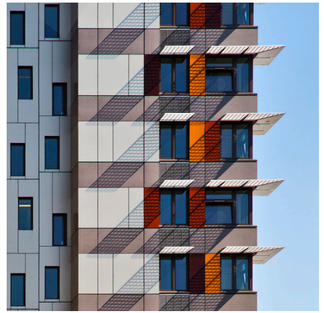
ADDITIVE + SUBTRACTIVE

The building's massing also uses additive and subtractive properties. If the "base" building height sits at the top of the shortest mass, the interior courtyard space is cut away and placed on top of the "base" height. This allows for a visual balance while still allowing for hierarchy in the design and fulfilling programmatic elements.

EXTERIOR FACADE | FIGURE 32

REPETITION

The material facade of Via Verde uses a repetitious coloring and patterning of windows and doors. All of the corners feature the same visual patterning and type of windows, while the units utilize the same colors per floor. Whole the patterning looks repetitious, it conveys a sense of playfulness and comes across as unified and clear.



EXTERIOR FACADE | FIGURE 33

GEOMETRY

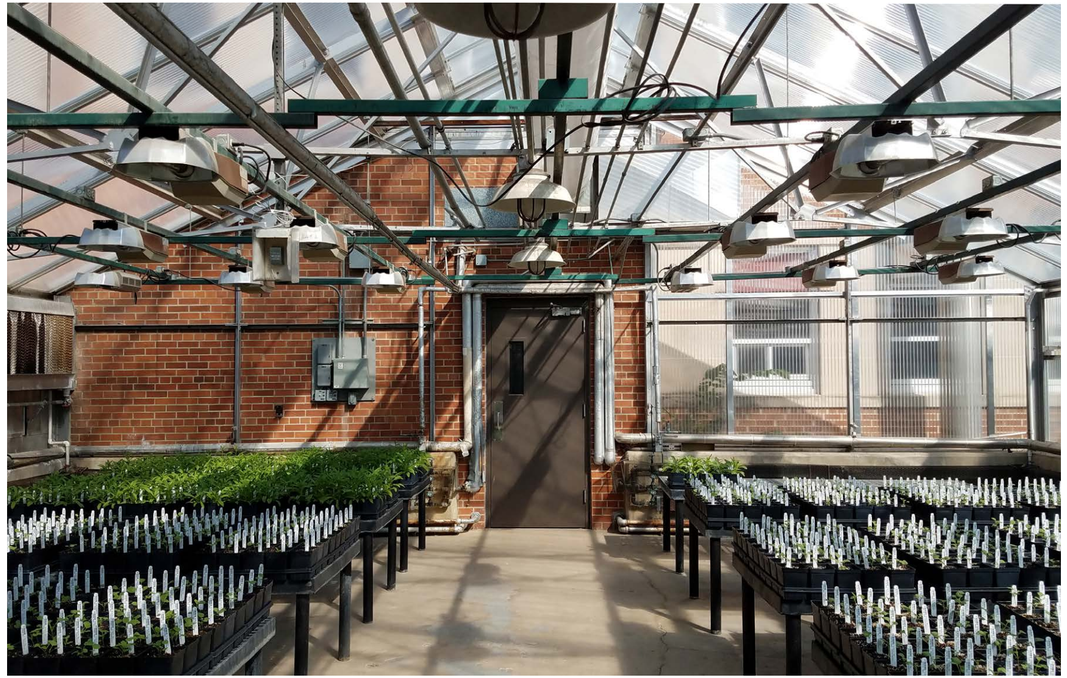
The overall geometry is rectilinear with only slight variation. The single example exists in the floor plan; it utilizes rectangles slightly rotated acutely to form a trapezoidal footprint. Otherwise, the rest of the design comes together in 90° angles. The rooftops, material paneling, furniture, and plant beds are all rectilinear.

VIA VERDE EXTERIOR PERSPECTIVE | FIGURE 34

DOES IT ALTER THE PREMISE?

Via Verde contributes to the theoretical premise of Relocated Roots by providing a world-renown solution that embodies the ideals and goals of the thesis. The redesign of 407 New Street wants to promoting and advocating social change – that is, to incorporate agriculture into their cities, and healthy food into their diets. Via Verde accomplishes this very concept, but for a different typology and city. It demonstrates a shifting mindset in the integration of landscapes in cities, and reaffirms the theoretical premise in its goals.

The theoretical premise is not altered by the conclusions drawn by Via Verde. Instead, the project reaffirms the underlying values and mission of the thesis. Dattner Architects and Grimshaw designed an awe-inspiring project that symbolizes a shift in the mindset of city design. The design of Via Verde represents a commitment to changing the culture and society of the Bronx, a historically tough part of the city. By undertaking a struggling site, incorporating principles of sustainability, and transforming it into a place of community and growth, the designers demonstrate that architecture can transcend its walls and roofs to become a symbol of possibility.



USDA GREENHOUSE INTERIOR | FIGURE 35

NON-TYPOLOGICAL RESEARCH

The Bioscience Research Laboratory (BRL) is a United States Department of Agriculture (USDA) maintained research facility on the North Dakota State University main campus in Fargo, North Dakota. The facility maintains six greenhouses with nine controlled spaces for experiments. This precedent study investigates Ranges #3 and #4, which are combined within a single story greenhouse design.

This precedent research study is non-typological; it investigates the thermal performance of the greenhouse typology, but not the function of a socialization space.

The BRL Greenhouse is exclusively a research facility. Its sole function is to house experiments and facilitate the development of ideas and knowledge in plant growth. This facility differs from the other precedent case studies in this primary function: it doesn't cultivate produce for consumption. Instead, it cultivates produce for learning. The conceptual foundation behind the BRL Greenhouse is learning, not eating. It doesn't engage the community in the way the others do, and it doesn't try to. A federal research facility is not the typology for community engagement, which is an appropriate response for their work.

The precedent research is conducted in pursuit of simulating conditions to reflect the reality of a multi-story greenhouse design. Its intention is to learn about the construction and behavior of single story greenhouses in order to apply the theories and techniques to the thesis design.

The study comprehensively examines the existing conditions of a single story greenhouse in a harsh midwestern climate. By inventorying this built design in a quantifiable, measurable investigation, the effectiveness of its thermal performance can be evaluated and conclusions can be drawn based on its results. The study begins by examining the effectiveness of an existing single story greenhouse design, then contrasts its findings with simulation results of the same design. The study then uses the combined data to determine the accuracy of the software. Once the software is validated or discredited, the findings will inform design decisions for an urban multi-story greenhouse.

A comprehensive report of the research findings is included with this thesis located in the official North Dakota State University Repository.

PROJECT ELEMENTS

COMMERCIAL SCALE GREENHOUSE | FIGURE 40

VERTICAL FARM | GREENHOUSE

Because of the limited open space in the city, finding workable farmland is challenging and sometimes nearly impossible task due to substantial property value costs. A building's rooftop provides an innovative and cost effective place for growing and nurturing urban agriculture. By utilizing an otherwise wasted space, the community can benefit from a educated redesign. Constructing a multi-story vertical farm atop a building can cultivate fresh produce for the surrounding community while possibly reducing the heat island effect of cities. This major project element is the central element within the thesis design.

There is a societal demand for high-quality food in cities, a call to reduce transportation pollution and a focus on sustainable architecture. A greenhouse can provide a solution that accomplishes these goals while also highlighting advances in agricultural technology. Though greenhouses are typically single story, a taller, multi-story design will both embody traditional techniques and build upon them with contemporary strategies. A vertical farm can provide a greater amount of fresh produce in a cleaner and more efficient facility than traditional farming, and thus demonstrate the feasibility of the project.

REGEN VILLAGES VERTICAL FARM | FIGURE 41

EL MERCADO ROMA | FIGURE 42

RESTAURANT

casual healthy eating

Relocated Roots intends to introduce a casual healthy eating restaurant on the first floor of the design. This space will provide opportunities for citizens to gather, dine, and enjoy healthy eating.

FARMER'S MARKET

Eating and drinking are common reasons for people to gather. With the availability of farm-fresh produce, a small restaurant and marketplace provide perfect opportunities for people to connect within Relocated Roots. Socializing with others is a fundamental part of a strong and lively community. By incorporating food-related community spaces, the design will integrate the agricultural component of the design with the community, adding consistent community exposure to the building's main function. Continual exposure and function integration will help agriculture assimilate into the urban environment. The more people are introduced and interacting with the farm produce grown in their city, the more likely they will become readily familiar with the concept of urban agriculture.

These spaces are intended to be fun and informal settings for community members to gather and relax. Both spaces will try to reflect nature through its spatial form and overall aesthetic. The interior design of the restaurant will need to create intimate yet inviting spaces, while the exterior plaza will need to showcase products and inspire conversations. By designing spaces for socialization and nature, the design attempts to bridge the gap between people's innate longing for nature and the disconnection of city living.

LAFAYETTE FARMER'S MARKET | FIGURE 43

CLIENT DESCRIPTION

PRIMARY CLIENT

The multi-story greenhouse atop Relocated Roots is commissioned by an urban agriculture company called Gotham Greens. Gotham Greens is a fictional client but a real company. They own and operate four commercial scale urban farming facilities across the United States, spanning approximately 170,000 SF of technologically advanced, 100% clean energy powered, climate-controlled rooftop greenhouses.

GOTHAM GREENS GREENHOUSE INTERIOR | FIGURE 44

GOTHAM GREENS FOUNDERS + CAO | FIGURE 45

"inspired by innovation and technology

driven by a sense of duty to address ecological issues facing our agricultural system"

When Gotham Greens built its first greenhouse in 2011, it became the first commercial scale rooftop greenhouse in the United States. Located in the Greenpoint neighborhood in Brooklyn, New York, Gotham Green's facility represents a shift in the industry of urban agriculture. No longer was city farming a seasonal community gardening concept. Their work transformed the industry into a year-round commercial scale farming enterprise.

In 2014, Gotham Greens constructed a second greenhouse in Brooklyn. This time, on the rooftop of Whole Foods Market store. This greenhouse represents another first in commercial scale urban agriculture: a farm facility fully integrated into a supermarket. In the last three years, Gotham Greens has open two additional greenhouses in New York City and Chicago and has expansion plans to operate in cities all over the country.

CLIENT DESCRIPTION

SECONDARY CLIENT

Relocated Roots is owned by one party but has several building users. The primary client, Gotham Greens, is the owner of the building, and they intend to lease space to a secondary client, Urban Harvest. Urban Harvest is an entirely fictional client who will rent a portion of the building for a casual restaurant and occupy the surrounding plaza during the summer months for their weekly indoor/outdoor farmer's market. Urban Harvest is a fictional company who specializes in public event organization and tourism. Their mission is to organize and integrate other local farmers into the Relocated Roots weekly market. Their investment into the building allows them to build their branding as a promoter of sustainable farming and public outreach. Urban Harvest intends to occupy the first floor of Relocated Roots with appropriate support facilities for their staff.

MARKET SHOPPER | FIGURE 46

GOTHAM GREENS EMPLOYEES | FIGURE 47

GOTHAM GREENS

primary client, building user

The primary client and building users of Relocated Roots are the employees and workers + the crops. The final design will consider their needs and attempt to provide proper conditions for optimal work and growing.

FARMER'S MARKET EMPLOYEES | FIGURE 48

URBAN HARVEST

secondary client, building user

The secondary client and building users of Relocated Roots are the employees of Urban Harvest. Their staff will require appropriate work conditions which include clean facilities for food prep and proper egress for their patrons.

USER DESCRIPTION

RESTAURANT PATRONS

To ensure product quality and safety, Gotham Greens employees are the only users permitted within the vertical farm. Their employees and plants are considered the primary users of the building. There will two departments for Gotham Greens employees: office and administrative, and greenhouse care. Office employees will focus on tasks like marketing, merchandising, and contracting. The greenhouse employees will manage the systems and care for the produce. There will be an estimated 10 full-time office employees working 8am-5pm, and 20 full and part-time greenhouse employees working varying shifts around the clock. The office employees will not have any physical requirements whereas the greenhouse employees will. Due to the nature of the work, they require the ability to lift 30lbs, stand for long periods of time and perform tasks repeatedly. They will need parking for their staff, as well as loading and unloading space for trucks.
The greenhouse will require many building elements to function successfully:

- Sufficient water sourcing and distribution
- Structural reinforcing for vertical plantings
- Large service elevator for equipment
- Exterior access door for even larger equipment
- Loading docks, pick up and drop off areas

BUILDING EMPLOYEES

The small, community focused restaurant within Relocated Roots will occupy the first floor with access to the exterior plaza and exhibition space. The restaurant patrons are considered the second user of the building. To accomodate them, the restaurant will operate during the day, to provide lunch for downtown business people as well as dinner for tourists and locals. However, the most influential time for it to be used is in conjunction with the farmer's market. The restaurant will provide around 75-100 interior seats, and must allocate parking for the patrons. The restaurant is intended to highlight some of the crops grown in the vertical farm as well as selections from other nearby farmers. The availability of purchasing local produce and enjoying local produce will help promote the message of sustainable urban farming.

MARKET SHOPPERS | FIGURE 49

CINCINNATI CITIZENS

The Urban Harvest Market Plaza is a space for Cincinnati citizens to purchase locally grown foods. This space will be used primarily during the weekends during the summer months: Saturdays and Sundays in May-October. During the non-peak seasons, the plaza will serve as open space for tourism or winter exhibitions. The residents of Cincinnati are the third building user, and possibly the most important.

In the 2010 US Census, there were 296,943 people living in the city. That number can be used to estimate how many people will visit Urban Harvest's Market Plaza. The Farmer's Market Coalition is a nonprofit organization dedicated to providing information and opportunities for farmers. They believe there are many ways to reliably estimate numbers of farmer's market visitors. The most common method is to strategically place staff at defined entry points and take count for every 15-20 minutes. Then, multiply that number by 4 or 3 to get your "hourly" visitors.

In Ruston, LA, they've recorded 858 and 1,509 visitors.
At a population of 22,370, that's 3.8% and 6.7%.

In New Orleans, LA, they've recorded 1,122 and 1,167 visitors.
At a population of 391,495, that's 0.28% and 0.29%.

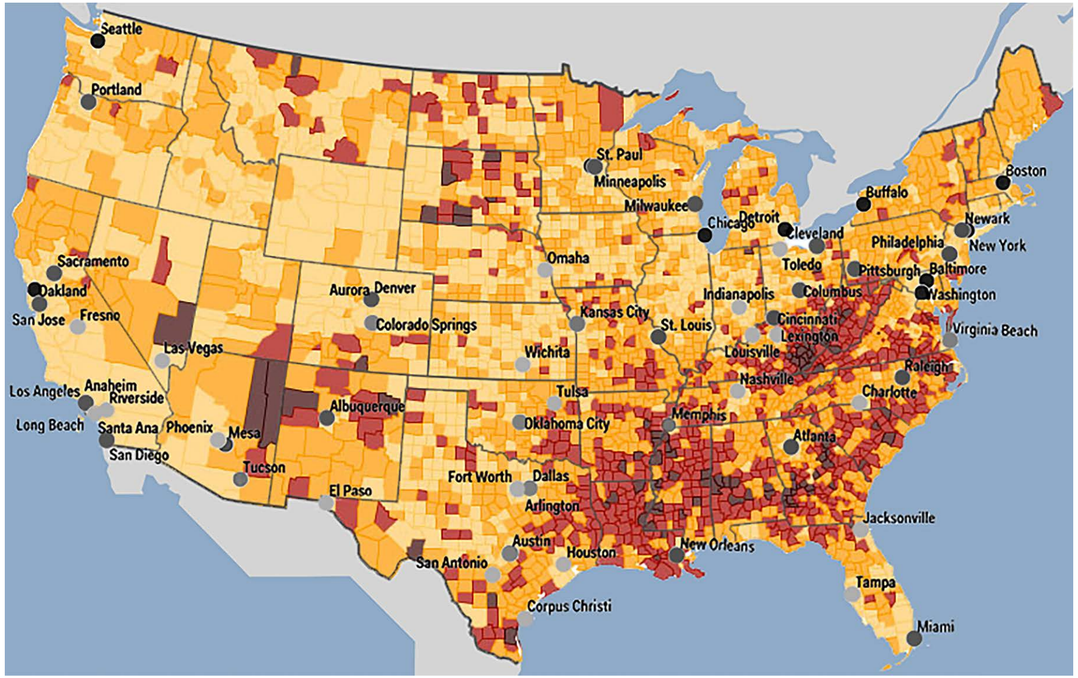
Because New Orlean's population is closer to Cincinnati's than Ruston's, the New Orleans percentages can be used to estimate Relocated Roots' farmer's market numbers:

296,943 x 0.28 = 831 visitors
296,943 x 0.29 = 861 visitors

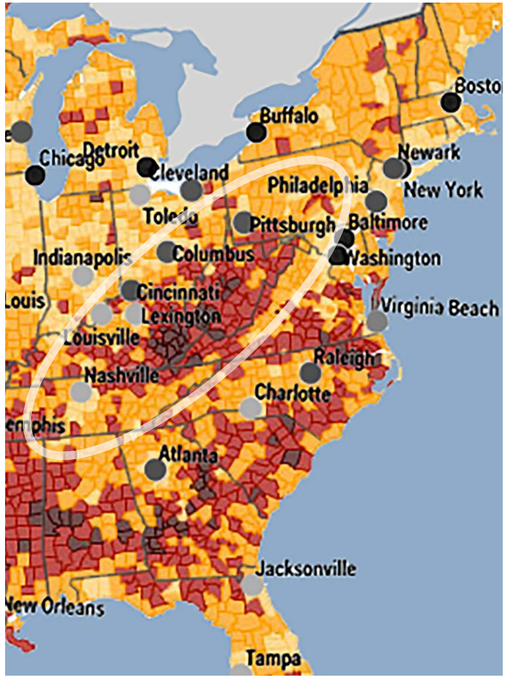
It can be difficult to estimate how many people to plan for, especially when visitor's data is so prone to error. When competing with other well established farmers markets in the area, these numbers seem to be a little unrealistic for the Urban Harvest Farmer's Market. **Planning for a more modest number like 300 people may be appropriate, so long as Relocated Roots will plan to leave space for additional facilities.**

The existing site serves as at-grade parking lot. It is clear that an extensive underground parking structure will be needed to serve the 8am-5pm downtown business people. Fortunately, the Market Plaza will operate on an opposite timetable, so they will have the ability to share space so long as both parties agree.

SITE INFORMATION



MAJOR US CITIES AND FOOD DESERTS | FIGURE 50



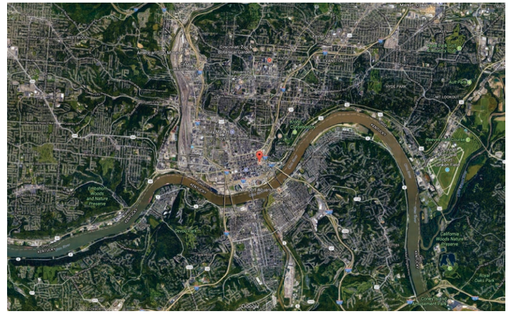
MAJOR US CITIES AND FOOD DESERTS | FIGURE 51

SITE SELECTION: REGION

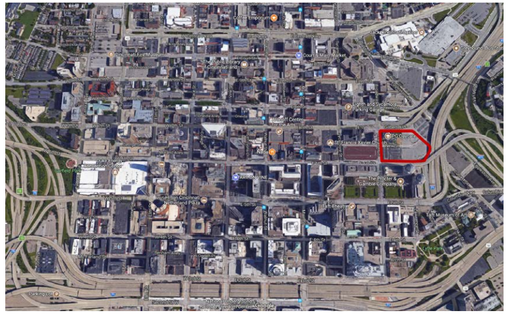
A food desert is an urban area where it is difficult to buy affordable or good-quality fresh food. This map shows the percentage of the population who don't own a vehicle and live more than 1 mile from a grocery store. The darkest colors mean more than 10% of the population live in a food desert. The lighter yellow colors fall closer to 2.5%.

There are two distinct areas of the country where there is a heavy concentration of people who live in food deserts: the first region falls over Louisiana, Mississippi and Alabama. The other covers Kentucky, West Virginia, and parts of Southern Ohio. This particular region is more populated than the other, and has a higher concentration of cities. For this reason, this area provides a better opportunity for implementing social change.

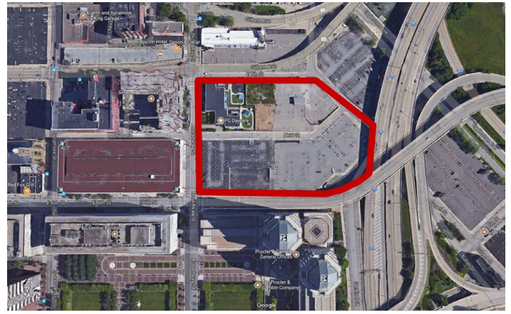
Cincinnati is a city in Ohio that lies right on the edge of this concentration of food deserts. It lies at the intersection of several interstates: 275, 71, 74, 75, 471. The city also has a high percentage of overweight and obese adults. A study in 2010 reported 64.9% of Cincinnati adults are overweight or obese (Gonzales 2014). Access to fresh food is known to be beneficial for combating health problems.



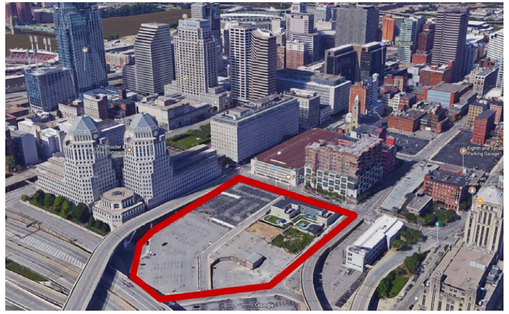
CITY OF CINCINNATI | FIGURE 52



DOWNTOWN CINCINNATI | FIGURE 53



IMMEDIATE CONTEXT | FIGURE 54



AERIAL VIEW, LOOKING SOUTHWEST | FIGURE 55

407 NEW ST, CINCINNATI, OHIO

This specific site is important to the design because it provides clear opportunities for the thesis premise:

01. The site exists within the urban context of a major United States city. It also is a city that lies on the edge of one of the largest concentrations of food deserts in the US. It is the hope that designing a fresh produce facility in this city will inspire smaller communities in the region to do the same.

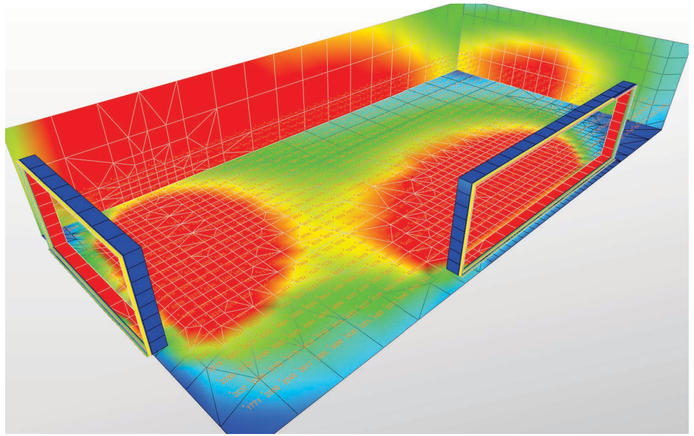
02. The site also exists in a city with extraordinarily high overweight and obese percentages among adults. An urban agricultural facility is appropriate for Cincinnati because it would provide a positive supply of fresh produce for the citizens. Healthy fruits and vegetables are known to reduce weight and health risks. By producing healthy foods so close to the source of the problem, Relocated Roots can provide people the tools they need to better themselves.

407 New Street is important because it is located adjacent to two major interstates. This proximity to vehicular circulation allows for maximum visual exposure. The architecture of Relocated Roots aims to promote and advocate social change, and this visibility will constantly spread the message to the hundreds of people using the interstate.

407 NEW STREET | FIGURE 56

407 New Street has the unique opportunity to revitalize an underutilized part of downtown Cincinnati. The current site is an at-grade parking lot and a redesign emphasizing community could really benefit the city. The site has connections to the interstate and public transit, and has already established itself as a useful asset. It is physically bounded by the interstate, but the noise and views won't bother the plants.

PROJECT EMPHASIS

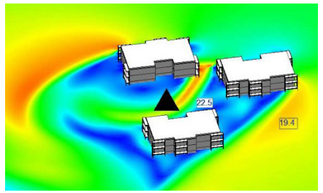


AUTODESK LIGHTING ANALYSIS | FIGURE 57

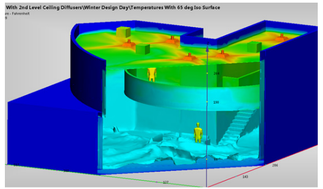
THERMOGRAPHY

visual heat mapping

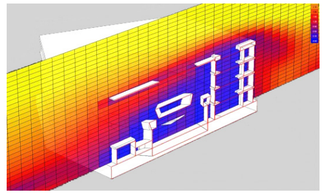
Utilizing infrared radiation to form an image reflecting the physical temperature of a subject.



AUTODESK FALCON | FIGURE 58



AUTODESK CFD | FIGURE 59



AUTODESK CFD | FIGURE 60

THERMAL PERFORMANCE

The material nature of greenhouses and the importance of sunlight in growing inspire a considerable emphasis on the thermal performance of Relocated Roots. Greenhouses are typically constructed using transparent materials like glass or polycarbonate in order to allow sunlight to penetrate and warm the space.

For a project this size, this much glazing would mean a substantial amount of radiant heat with a high window to wall ratio. This causes concern for summer months when the external temperatures are already so high. Multi-story spaces are prone to unequal heat distribution and with the added heat loads, it will be important to address thermal performance goals early on.

More than ever, design tools and technology have the ability to reflect the reality of a building's thermal design. Software like Autodesk CFD, Flow Design, and Revit are increasingly critical in calculating how a building's fenestrations and materials are operating. Simulations of building performance will guide the project to success. The results of early energy modeling will inform many design factors such as massing, material, orientation and window/wall ratios. At the end of the project, the simulation results will also provide justification that the building's thermal performance achieves its sustainability goals.

Identifying strategies in heat gain/loss, optimizing design factors such as massing and materials, and demonstrating their effectiveness will either prove the success of the design, or indicate which areas need attention.

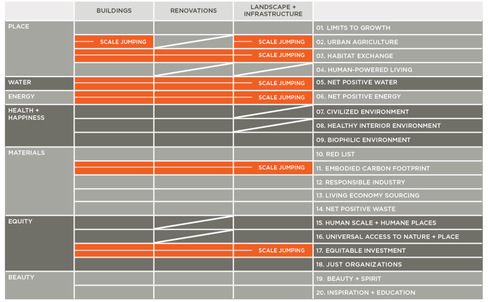
PROJECT GOALS

The Academic Goals of Relocated Roots are focused towards environmental sustainability and the community's social well being. The community and the crops will require different considerations, therefore, the academic goals for the project revolve around achieving two sustainable design certifications:

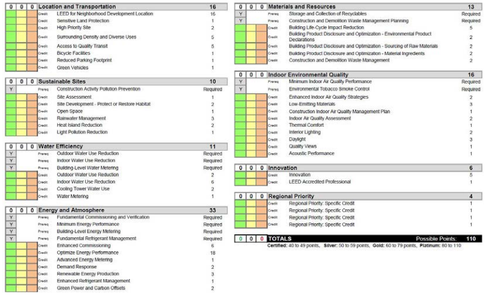
Pursuing a LEED Certification increases the value, environmental integrity, and media exposure of the design. Achieving a Platinum or Gold Rating would ensure the project's sustainability goals are met as well as the promotion and advocation of social change.

Pursing an LBC Certification demonstrates that the building "gives more than it takes, creating a positive impact on the human and natural systems that interact with them." This sustainability design framework aligns with the project's goals of giving back to the community.

Relocated Roots' goals are to conduct research and use that knowledge to design well-informed. It aims to contribute to the design field's understanding and acceptance of city farming. The project learns, discovers and experiments with techniques to integrating urban agriculture.



LBC CERTIFICATION MATRIX | FIGURE 61



LEED CERTIFICATION MATRIX | FIGURE 62

USGBC LEED CERTIFICATION

goal or platinum certification

LEED Gold®: 60-79 points earned
LEED Platinum®: 80+ points earned

LIVING BUILDING CHALLENGE

petal or living building certification

Requires at least three of the seven Petals, one of which must be either Water, Energy or Materials.

WINDY CITY HARVEST | FIGURE 63

PROFESSIONAL GOALS

Due to its unique subject matter, it is unlikely that Relocated Roots will directly relate to the typological specialties of typical architecture firms. Instead, the professional goal of this thesis is to convey creativity, resourcefulness and a profound compassion for the environment. Building familiarity with certification programs, knowledge of sustainable design practices, and skills for software modeling are also professional goals of this thesis project.

Relocated Roots aims to demonstrate my ability to conceive and articulate an idea, research and examine thoroughly and communicate a quality design effectively. At the conclusion of the project, the professional goal of Relocated Roots will be to exhibit my technical abilities and personal ideals. The thesis is crafted with great care and integrity in hopes that it will translate into my capabilities as its designer.

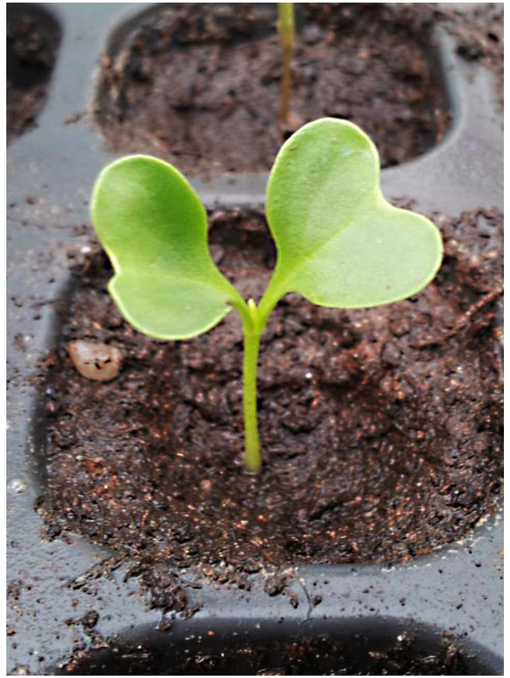
PERSONAL GOALS

There's a lot to be said about passion - If you love what you do, you'll never work a day in your life. My academic career in Architecture and my personal affinity for gardening have been building towards this project for years. With this thesis, I saw the opportunity to weave these two passions and try to create something truly meaningful.

More than anything, I want Relocated Roots to be the best work I have ever done. The concept of urban agriculture is so new and formative that it needs to be addressed more creatively, more intentionally, and more technically than any studio or professional project I have ever designed. I hope to recognize the challenges of urban agriculture and work towards finding a beautiful, environmentally focused, comprehensive design. It is my earnest hope that one day, I'll look back at this time in my career and feel proud to have pursued Architecture as a method of promoting social change.

"All of the Flowers of all the Tomorrows Are in the Seeds of Today.."

- Native American Proverb



SEEDLING | FIGURE 64

DEFINITION
of research direction

1. Theoretical Premise

How can architecture promote and advocate for social change, while facilitating the integration of agriculture into the urban environment?

Areas of focus include analyzing symbolic architecture and design that significantly impacts a community. LEED certified and LBC buildings will be given priority for their sustainability emphasis. The investigation will strive to find similarities between the projects. The research will be done in the form of precedent studies analyzing specific attributes such as extraordinary circumstances, bold goals and impressive success.

2. Project Typology

Multi-story Greenhouse

An investigation into the greenhouse typology will be included in the thesis project. Investigating the elements of greenhouse design will contribute to the development of a design with multiple stories. Areas of focus include structure, ventilation, growing techniques and optimal conditions. The research will be done in the form of a comprehensive case study with CFD simulations and literary review.

3. Historical Context

History of agriculture + the beginnings of vertical farming

Setting the historical context for the design will be important to the project. Research into the origin of agriculture and its affects on society will provide both knowledge and inspiration for this community-driven design. Because vertical farming is a relatively new concept, investigating its beginnings will provide insight into its challenges and necessities.

4. Site Analysis

A comprehensive investigation of 407 New Street

An analysis of the site will be required for the design. By inventorying site elements like circulation, sun, wind, climate, etc. the design can attempt to maximize opportunities.

5. Programmatic Requirements

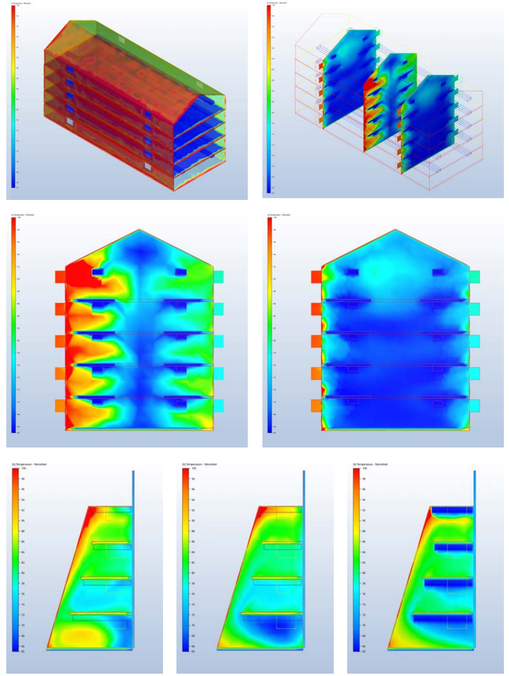
Research into size requirements

In order to achieve performance goals, an adequate amount of space will be required for the design. Precedent studies into other successful vertical farms will serve as the basis for the space allocation numbers. The final square footages will come from site inventory and schematic design.

METHODOLOGY
a system for research conclusion

At the conclusion of the proposal, a digital site context model will be developed for Sketchup, Revit and Infraworks. This model will provide insight into contextual considerations such as massing, solar orientation and circulation. Utilizing Revit Massing and Autodesk CFD, many design masses will be explored early in the design process. Several options developed from the context model will be assessed via thermal simulation to determine which forms successfully perform. The most promising iteration will then be fitted with spaces as determined in the space allocation charts. Once the massing has accommodated the project program, further development of the design will proceed without major design changes.

Due to the iterative nature of simulation, a thorough method for documenting design options will need to be developed. A considerable amount of time will be dedicated at the front end of the design process for schematic massing. A method for comparing the iterations will also be critical for assessing the performance of each mass. The final design will be completed by mid-semester critiques on March 5th. The remainder of the semester will incorporate the feedback received and final production will begin.



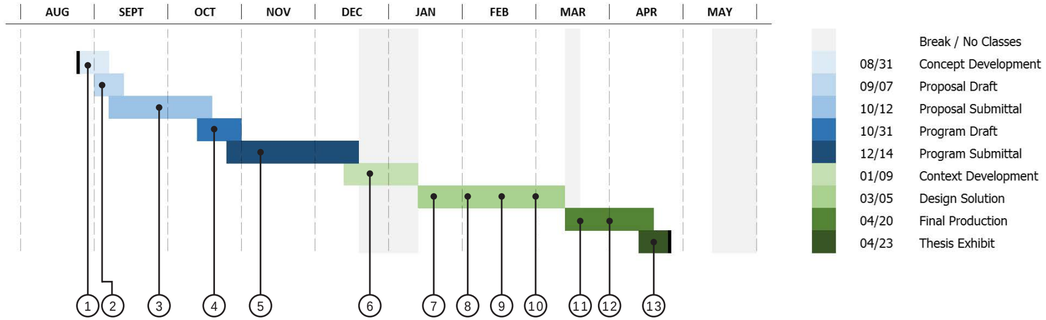
CFD SIMULATIONS | FIGURE 65

PROCESS DOCUMENTATION

The investigation of design options will occur both artistically and digitally - through the use of hand sketching, model making, and computer representation: BIM and CAD. Direct feedback from the thesis advisor will be incorporated into the design project weekly and in-studio critiques from peers will be considered accordingly. All physical design development materials will be preserved in well-maintained sketchbooks and binders. Research and image sources will be recorded and cited as referenced.

The design process will be recorded within a single comprehensive document, from initial proposition through precedent research and investigation of design options. The completed project book will also include the final design solution. The final thesis exhibit will be installed during the week of April 23rd through May 11th, 2018. A complete record of the thesis project will be submitted to the North Dakota State University Institutional Repository to be accessible by ALA students and the general public.

SAMPLE OF THE ITERATIVE PROCESS | FIGURE 66



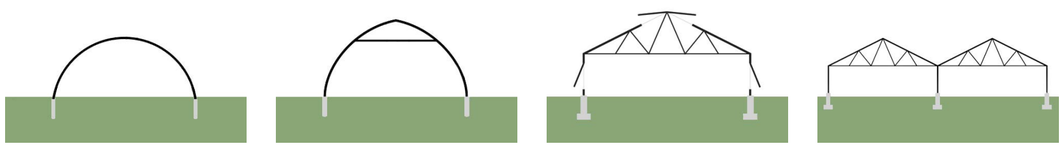
FALL

1. theoretical premise development
2. project proposal + peer feedback
3. project proposal: precedent studies + typologies
4. project program + peer feedback
5. project program // space allocation + literary review
6. develop context model // physical + digital

SPRING

7. schematic massing // initial performance analysis
8. floor planning + spatial organization
9. section, elevation and sun studies
10. mid-semester critiques
11. incorporate feedback and finalize development
12. presentation production
13. install final exhibit and thesis reviews

GREENHOUSE STYLES



GREENHOUSE TYPES | FIGURE 67

Round Arch

Cost: Relatively inexpensive
Structure: Simple, no trusses
No foundation for single stories

Light: Excellent all day long
Align: Long axis North to South
Snow: Poor performance, does not shed well

Pros: can be hundreds of feet long
Cons: difficult to ventilate

Gothic Arch

Cost: More expensive than round
Structure: Simple structure
May add cross bars in center

Light: Excellent all day long
Align: Long axis North to South
Snow: Excellent - sheds well, beware snow gathering around base

Pros: can be hundreds of feet long
Cons: difficult to ventilate

Traditional

Cost: Engineered trusses are costly
Structure: Very sturdy, good long term. Will require foundation.

Light: Excellent all day long
Align: Long axis North to South
Snow: Excellent - sheds well

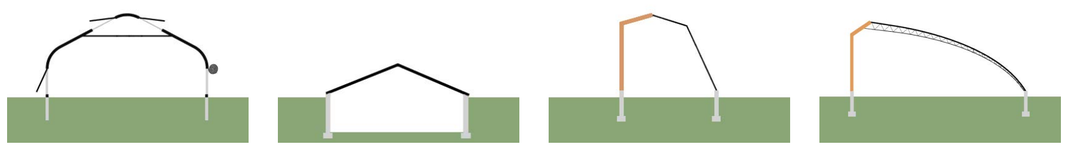
Pros: Most popular style, easy to ventilate due to straight surfaces
Cons: Expensive

Gutter Connect

Cost: Expensive, especially commercial scale
Structure: Will require foundation, option to remove sidewalls

Light: Excellent all day long
Align: Long axis North to South
Snow: Poor performance

Pros: Great for large operations
Cons: Precipitation collects in gutters



GREENHOUSE TYPES | FIGURE 68

Gothic Traditional

Cost: Same as Gothic Arch
Structure: No foundation necessary

Light: Excellent all day long
Align: Long axis North to South
Snow: Excellent - sheds well

Pros: Easy to ventilate due to straight surfaces
Cons: Rounded rigid glazing can be expensive

Walipini

Cost: Expensive in some regions
Structure: Sandbag or cinder block walls

Light: Poor morning and evening
Align: Long axis North to South
Snow: Poor performance, collects

Pros: Thermally insulated
Cons: Animals and people can walk right over it

Passive Solar

Cost: Same as Gothic Arch
Structure: Engineered

Light: Poor morning and evening if using insulated walls
Align: Long axis North to South
Snow: Excellent - sheds well

Pros: Energy savings
Cons: Angle of glazing reduces usable vertical space

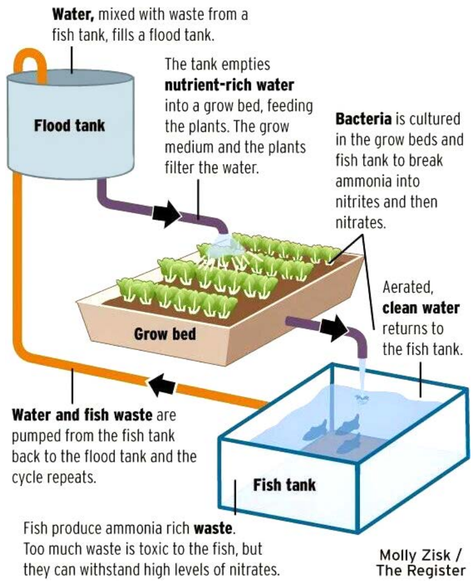
Chinese

Cost: Same as Gothic Arch
Structure: If commercial, long spans and trusses are needed

Light: Poor morning and evening if using insulated walls
Align: Long axis North to South
Snow: Excellent - sheds well

Pros: Good for cross ventilation
Cons: Angle of glazing strains use

MODERN GROWING TECHNIQUES



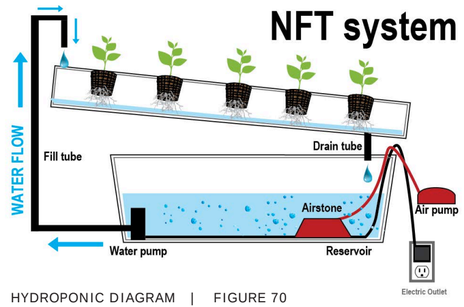
AQUAPONIC DIAGRAM | FIGURE 69

AQUAPONICS
fish integrated, water solution

Hydroponics is a modern farming technique that incorporates the use of fish waste as a nutrient for plants. The diagram to the left describes the process of hydroponics: nutrient-rich water leaves the flood tank to feed the plants, the plants break down the ammonia into nitrates which cleans the water. The clean water is returned to the fish where they live and produce waste. Fish waste contains ammonia, which is pumped back up the flood tank where it is mixed with other nutrients beneficial to the plant.

This type of growing is symbiotic, where both the plants and the fish benefit from the relationship. It becomes a micro-ecosystem where the plants and fish exist in harmony. Because the two benefit one another, Aquaponics significantly reduces water use, even more than hydroponics and aeroponics. It uses only 1/10th of the water needed for traditional soil farming. It relies on the nature of plants and fish to recycle the water and filter out the harmful chemicals.

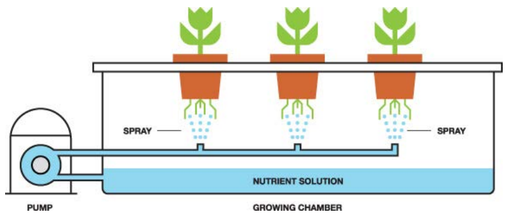
Relocated Roots will utilize modern growing techniques in its vertical farm design. The sustainable use of water aligns with the project's goals to preserve the environment.



HYDROPONIC DIAGRAM | FIGURE 70

HYDROPONICS
soiless, water solution

Hydroponics is a type of hydroculture growing. The diagram left depicts a nutrient film technique (NFT), which is a system where plant roots are suspended directly into water with no growing medium. It is soiless. Water is pumped into the drip tray where plants absorb what they need. The unused water drains back into the reservoir where additional nutrients are added to maintain the proper mixture. This system reduces water use and is light weight.



AEROPONIC DIAGRAM | FIGURE 71

AEROPONICS
soiless, mist solution

Aeroponics is a variation of hydroponics. It utilizes the same principle of soiless, suspended growing. Plant roots are again suspended above a drip tray, or directly above the growing chamber but instead of applying a liquid to the roots, Aeroponics sprays a fine mist. This system is also light weight and reduces water use significantly compared to traditional growing techniques.

The 150 favorite pieces of American architecture, according to the public poll "America's Favorite Architecture" conducted by The American Institute of Architects (AIA) and Harris Interactive, are as follows. For more details on the winners, visit www.aia150.org.

Rank	Building	Architect
1	Empire State Building - New York City	William Lamb, Shreve, Lamb & Harmon
2	The White House - Washington, D.C.	James Hoban
3	Washington National Cathedral - Washington, D.C.	George F. Bodley and Henry Vaughan, FAIA
4	Thomas Jefferson Memorial - Washington D.C.	John Russell Pope, FAIA
5	Golden Gate Bridge - San Francisco	Irving F. Morrow and Gertrude C. Morrow
6	U.S. Capitol - Washington, D.C.	William Thornton, Benjamin Henry Latrobe, Charles Bulfinch, Thomas U. Walter FAIA, Montgomery C. Meigs
7	Lincoln Memorial - Washington, D.C.	Henry Bacon, FAIA
8	Biltmore Estate (Vanderbilt Residence) - Asheville, NC	Richard Morris Hunt, FAIA
9	Chrysler Building - New York City	William Van Alen, FAIA
10	Vietnam Veterans Memorial - Washington, D.C.	Maya Lin with Cooper-Lecky Partnership
11	St. Patrick's Cathedral - New York City	James Renwick, FAIA
12	Washington Monument - Washington, D.C.	Robert Mills
13	Grand Central Station - New York City	Reed and Stern; Warren and Wetmore
14	The Gateway Arch - St. Louis	Eero Saarinen, FAIA
15	Supreme Court of the United States - Washington, D.C.	Cass Gilbert, FAIA
16	St. Regis Hotel - New York City	Trowbridge & Livingston
17	Metropolitan Museum of Art – New York City	Calvert Vaux, FAIA; McKim, Mead & White; Richard Morris Hunt, FAIA; Kevin Roche, FAIA; John Dinkeloo, FAIA
18	Hotel Del Coronado - San Diego	James Reid, FAIA
19	World Trade Center - New York City	Minoru Yamasaki, FAIA; Antonio Brittiochi; Emery Roth & Sons
20	Brooklyn Bridge - New York City	John Augustus Roebling
21	Philadelphia City Hall - Philadelphia	John McArthur Jr., FAIA
22	Bellagio Hotel and Casino - Las Vegas	Deruyter Butler; Atlandia Design
23	Cathedral of St. John the Divine - New York City	Heins & La Farge; Ralph Adams Cram
24	Philadelphia Museum of Art - Philadelphia	Horace Trumbauer, Zantzinger, Borie, and Medary
25	Trinity Church - Boston	Henry Hobson Richardson, FAIA
26	Ahwahnee Hotel - Yosemite Valley, CA	Gilbert Stanley Underwood
27	Monticello - Charlottesville, VA	Thomas Jefferson
28	Library of Congress - Washington, D.C.	John L. Smithmeyer, FAIA and Paul J. Pelz, FAIA
29	Kaufmann Residence (Fallingwater) - Bear Run, PA	Frank Lloyd Wright
30	Taliesin - Spring Green, WI	Frank Lloyd Wright
31	Wrigley Field - Chicago	Zachary Taylor Davis
32	Wanamaker's Department Store - Philadelphia	Daniel Burnham, FAIA

AEROPONIC DIAGRAM | FIGURE 72

INFLUENTIAL ARCHITECTURE

People are busy. The average person goes about their days, minding their own problems and challenges without deeply questioning why some buildings are "better" than others.

That's why the public's choice for the top 150 architectural designs are meaningful. In 2006 and 2007, the American Institute of Architects (AIA) polled the general public for their favorite pieces of American Architecture. The results tell us, the designers, which projects are making an impact on them. By knowing which designs are influential, we can try to decipher why these projects do so. This type of inductive logic will help recreate/reinterpret the successful elements in order to create more meaningful architecture.

Relocated Roots' goal is to create a design that makes an impression - that does more than just exist as a building. It aims to serve as a symbol of values, just as these designs do. By inventorying why these designs are successful, it can attempt to incorporate the same principles.

Name: Empire State Building
Location: New York City, NY
Style: Art Deco
Year: 1931

Iconic Characteristics:
- Incredible construction speed
  1 floor per day, only 13.5 months total
- Tallest building in the world for ~40 years
- One of the Seven Wonders of the World
- Pop culture icon from films like King Kong and An Affair to Remember

Name: The White House
Location: Washington, DC
Style: Neoclassical
Year: 1800

Iconic Characteristics:
- The facade was originally created with lime based whitewash in 1798
- Was burned to the ground in 1814
- The north and south portico were added in 1824 and 1829, inspired by Ancient Greece
- Part of a 18th century rise in Neoclassicism

Name: Washington National Cathedral
Location: Washington, DC
Style: Gothic Revival
Year: 1990

Iconic Characteristics:
- Second-largest church building in the US
- Construction lasted 83 years, with carvings and other decorative work still ongoing
- The seat of the Episcopal Presiding Bishop
- Pop culture icon for its role in Presidential state funerals and inauguration prayers

Name: Fallingwater / Kauffman Residence
Location: Mill Run, PA
Style: Modern/Organic
Year: 1939

Iconic Characteristics:
- Listed by the AIA in 1991 as the all-time best work of American Architecture
- Listed as a National Historic Landmark
- Daring structural feats: cantilevered partly over a waterfall
- Seamlessly blends nature with design

Name: Willis Tower, formerly Sears Tower
Location: Chicago, IL
Style: Modern
Year: 1973

Iconic Characteristics:
- Tallest building in the world for ~25 years
- 110 stories tall, with a revolutionary bundled tube structural system
- First building to utilize the tube structure, has been highly influential in all skyscapers since
- The world's tallest steel-construction building

Name: Hearst Tower
Location: New York, NY
Style: Structural Expressionist
Year: 1990

Iconic Characteristics:
- First "green" high-rise office building in NYC
- Also NYC's first LEED Gold Skyscraper
- Heart Tower's base was building eighty years prior to its tower
- 85% of its structural steel contains recycled material, iconic example of diagrid structure

Name: Solomon R. Guggenheim Musem
Location: New York, NY
Style: Modern
Year: 1937

Iconic Characteristics:
- Uniform form: cylindrical with a wider top than base, a "temple of the spirit."
- Incredible atrium and skylight
- Controversial, rivals the artwork within?
- In sharp contrast to both the color and shape of surrounding Manhattan buildings

Name: Disney Concert Hall
Location: Los Angeles, CA
Style: Postmodern / Blobitecture
Year: 2003

Iconic Characteristics:
- Visually unique stainless steel skin
- Bold exterior form pushed boundaries of CAD software and construction methods
- Controversial cladding: the form and skin caused additional heating costs for neighbors
- Incredible acoustic performance

Name: Seattle Central Library
Location: Seattle, WA
Style: Postmodern
Year: 2004

Iconic Characteristics:
- Visually unique and crystalline geometry
- Iconic diagrid system with 11 stories of jagged glass skin
- Controversial form: confusing, impersonal, oppressive? Mixed critics.
- Design philsophy to allow function to dictate

THESIS RESEARCH SUMMARY

FINDINGS FROM AIA'S BEST ARCHITECTURE

These nine designs are picked among the list of the AIA's America's Favorite Architecture. They span over 200 years, through decades of progressing architectural styles, from all shapes and sizes.

Some designs from the list are old. The design is meaningful because it has become a part of the history of our country. They are embedded in our culture because they are an integral part of our functioning society and we have grown up learning about them.

Some designs from the list are meaningful because they accomplish the world's biggest, the city's first, and so on. The designs push the boundaries of what is possible and they make their impression on society because they achieved something incredible.

Some designs on the list are controversial. The work is both praised and criticized. This kind of notoriety can be good, especially if the resounding feedback is supportive. But it can also be bad, as design can stand out for the wrong reasons.

Some designs from the list are popular because they are shown/depicted on the media. Designs can be immortalized in books, tv shows, and news stations. Architectural design provides the setting and the background for stories to take place. This kind of exposure can help designs become household names and common knowledge.

But most of all, these designs are on the list of America's Favorite Architecture because they stand out. They do something different than the rest of the field and because of this, the work becomes a part of our culture and our values. By seeing our world progress and boundaries pushed, we too start to believe that we can do incredible things. Architecture can promote and advocate social change through its design by incorporating principles that promote the health and wellness of our communities. Inspiring others starts by creating inspiring architecture.

"We shape our buildings
Thereafter, they shape us.."

- Winston Churchill

SEATTLE PUBLIC LIBRARY INTERIOR | FIGURE 73

WHAT MAKES ICONIC ARCHITECTURE?

Architecture is the physical manifestation of a society's culture. It is a three-dimensional representation of the inhabiting people's values, ideals and principles. Because Architecture is an integral part of the built-environment, its symbolism can influence the public's perception of society as a whole. It can facilitate the transition of agriculture into an urban environment by promoting the good and demonstrating the incredible results. The thesis premise resolves around this belief: an idea can become implementation, and with exposure and powerful results, it assimilates into a culture.

To make a lasting impression on the architecture world, a project must some unusual element or original "thing" that it transforms into an extraordinary opportunity. Something atypical in a design must be capitalized upon in a unique and different way if it's going to stand out. In Vertical Harvest, the designers selected the site as their unique component. The building design is nestled into the side of an existing parking garage, and despite the unattractiveness of that situation, the project shines with eco-friendly solutions and beauty. In Via Verde, the site was also its unique component. Located in the Bronx New York, in a battered part of the city that needed hope, Via Verde introduces principles of community and holistic wellness. In the nine buildings pulled from the AIA's list, it's feats like height, form, sustainability and originality. By utilizing an unusual element and transforming it into the most interesting part of a design, a building is able to break the mold and stand out amid the field. Standing out makes a design noteworthy. An idea becomes implementation and if it's done well, standing out makes an impression.

The seemingly unattainable goals and success of a design also play a critical role in the perception of the project. Would we adore the Empire State Building if it didn't achieve the most incredible feats in structure and construction speed? Perhaps not to the same degree, but the other precedent studies also capitalize on the idea of bold ambitions and impressive success. In Vertical Harvest, they sought to produce 100,000 lbs. of produce annually. With a building footprint of only 1/10th of an acre, they are able to grow the same amount of food as 5 traditional acres. This is an astounding amount of food for so little space. With the ability to produce like this, that other communities are asking to replicate their model isn't surprising. Via Verde also mimics this ambition, but in a different way. It still pushes the boundary of its typology. With 250+ residential units, the design marks the next generation of affordable housing and sustainable living. Both of these cases achieve great things for their communities.

This idea of unattainable goals and impressive success also applies to the buildings from the AIA's list. A few examples could be: Fallingwater pushed the physical boundaries of cantilevering and its success attribute to the absolute beauty of the design. Gehry's Disney Concert Hall redefined architectural drafting by using CAD software for jet planes, not buildings. Willis/Sears tower created an original structural system that revolutionized the way we build skyscrapers today. The list of iconic architecture's accomplishes goes on and on, but the message is clear. Design must dream big.

This model of unusual element and bold ambitions armed with impressive success only comes to fruition if the design is intentional. Good architecture doesn't just happen. Pragmatic architecture that provides a solution for one particular client doesn't necessarily accomplish any world-changing actions, and yet, pragmatic architecture can still improve the lives of the community. Intentional architecture makes a lasting impression on people because it symbolizes hope, ingenuity and possibility of a stronger future. Relocated Roots attempts to tap into that intention to shift the mindset of the public towards meaningful communities and wellness. Intentional architecture is the implementation of an idea, which with exposure and powerful results, it assimilates into a culture.

BURJ KHALIFA, WORLD'S TALLEST BUILDING | FIGURE 74

PROJECT JUSTIFICATION

Urban agriculture is relatively new and formative concept. Because it hasn't been fully established as a "standard" within building design, the task of demonstrating why it's imperative to an increasingly urbanizing society is an appropriate one. If we as a society are to accept city farming as a viable method of producing food, the feasibility of this idea must be proven. The trend of urbanization creates an increase in population within already densely occupied places. This surge in city living decreases the available space for farming, while also increases the demand for food. City farming reduces pollution from vehicles transporating produce and creates a self-sustaining city model.

A comprehensive building design for a commercial farming facility is a challenging and appropriate final project for the thesis. Its design requires considerable attention because of its intense implications for Structure and MEP systems. The theoretical premise of initiating social change inspires a more creative, intentional, and technical solution than a majority of commercial architecture. The design of a futuristic farming facility will exhibit strong technical abilities in modeling, drafting, and simulations as well as personal ideals for environment and sustainability. A successful, atypical typology like an urban agriculture facility will convey creativity, resourcefulness and knowledge as well as a dedication to the discipline of architecture.

COMMUNITY-DRIVEN GROWING | FIGURE 75

Commercial farming is a viable business opportunity. Because of its foothold in monetary return, Relocated Roots is a calculated and smart development for the company's growth. Expending the funds for this project is a bold and leading-edge business opportunity for a company like Gotham Greens, whose mission is built on innovation and social influence. In order to create lasting impression, Architecture or design must be distinct and take advantage of an opportunity to create a significant impact. In order to achieve this, and prove this is a viable business move, funds must be spent.

Those funds will come from the existing multi-million dollar company, Gotham Greens. They are a real company, but a fictional client. Gotham Greens operates four commercial urban farms through NYC and Chicago, and a jump into the Cincinnati market would not be outlandish. The company generates money from investing, selling goods, and other means. Therefore, the design of Relocated Roots is not a frivolous pet-project, but a business opportunity, and all efforts to consider the cost and price will be made.

The business component of the design has a monetary return. Money and time goes into designing this urban farming facility which grows the crops and then sells them for a profit. The intangible value or latent return of the project comes from its impact on the local culture. How will it influence the social landscape of urban agriculture? To do this, the environment will need to be made in strong consideration for this project. Relocated Roots aims to influence the city's inhabitants, and it will do so, by reducing transportation of food to the city. This directly influences the amount of air pollution and reliance of fossil fuels. The project will also provide a more efficient and sustainable way of growing food, reducing the strain on the farmlands both far and nearby. By providing fresh produce grown directly in the city, the project will both help the environment and the Cincinnati Residents achieve better health and wellness.

I have always been interested in design that engages communities and does more for the people than just exist. Symbolic architecture, works like the Empire State Building and the Capitol in DC, symbolize values that we share as Americans: strength, order, pushing the boundaries of what's possible. It fascinates me that a building could influence the principles that people have. A modern urban agriculture facility that emphasizes social change could be one of those buildings. Its ability to influence the greater perception of agriculture is why this design is justified to be an appropriate final project. It begins by opening conversations and shifting the mindsets of people around me. Social change is a hard feat to accomplish all at once – it must start with one, grow to a few, and eventually could impact many.

ANCIENT AGRICULTURE

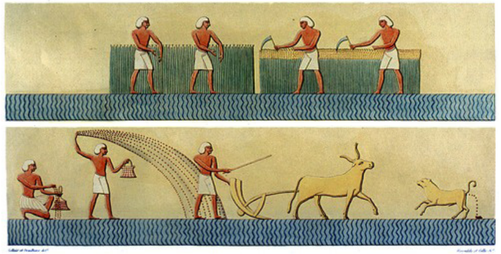
Agriculture is the active production of plants or animals in human created ecosystems. Because it is a cultural phenomenon, agricultural practices are inherited from one generation to another. This leads to its considerable variations across regions throughout time. Due to its varied and ambiguous beginnings, agriculture has no single, simple origin. It developed independently in many regions around the world with different and unique methods in each. The practice of clearing land, tilling soil, and domesticating crops was universal, and its use marked the first profound change in the relationship between modern humans and the environment.

Though humans evolved into our current form around 200,000 years ago, we did not begin to practice agriculture until about 15,000-10,000 years ago. The practice of settling down and growing food instead of hunting and gathering led to more food for less work. Agriculture in essence facilitated the establishment of the earliest civilizations - about 5,000 before the present.

Ancient civilizations grew early versions of many types of crops that still exist today: barley, wheat, flax, apples, plums and grapes are a few. They didn't plant just food: they grew cotton and hemp for clothing, coffee and coca for medicine.

With permanent settlements, ancient people were able to keep sheep, goats, cows and other animals. An ancestor of the modern day horse was likely domesticated by pastoral nomads around 6,000 years ago. Both the horse and the onager served critically in farming techniques as draft animals for plowing and digging irrigation canals.

Early farmers developed tools to ease the workload as well. Sickles made of flint and later iron and bronze were developed around the Roman Empire era. Watermills and dams helped grind the grains and cut the wheat easier. Large technological advances over the next couple thousand years made way for the farming we know today (Crawford n.d.).



HIEROGLYPHS IN RAMSES III TOMB | FIGURE 76

ANCIENT EGYPTIAN HIEROGLYPHS | FIGURE 77

MAJOR ADVANCES

Once humans had developed the foundations of practicing agriculture, the next 10,000 years were used to create technological advances to ease workloads and maximize production (Crawford n.d.).

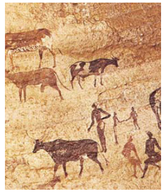


FIGURE 78

FIGURE 79

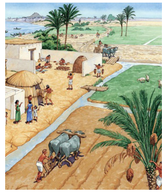


FIGURE 80

FIGURE 81

FIGURE 82

FIGURE 83

FIGURE 84

FIGURE 85

About 11,700 YA	About 8,000 YA	About 5,000 YA	200 bce to 600 ce	600 to 1600 ce	1901 - 2000	Today	About 15,000 YA
Beginnings	Farming Communities	Civilizations	Culture	Medieval Period	The Twentieth Century	Contemporary Agriculture	Urban Agriculture
The first people began practicing agriculture (plant and animal management) around the end of the Ice Age. Glaciers melted, and ecosystems worldwide reorganized.	With the ability to grow food, hunting and gathering practices were less utilized and people began to settle in permanent locations. This led to communities, trading, and irrigation.	Armed with technology like the plow, sickles, and wagons, villages evolved into entire societies. People and animals were assigned with specific tasks and the workforce transformed.	By Roman times, crop farming and domesticated animals were well established. With the abundance of food, people were able to pursue philosophy, science, art and culture.	Despite the disease and famine that plagued Medieval times, farmers developed the systematic organization of acres to divide land and maximize tool use which they improved with metals.	Agricultural technology developed more quickly in the 20th century than in all previous history. The invention of the internal combustion engine revolutionized farming as a new power source.	Today's farms look drastically different than they did even a century ago. Agriculture today is highly mechanized and controlled: synthetic fertilizers, pesticides and genetically modified foods.	While the future is still uncertain, agriculture has taken steps towards cultivation in skyscrapers. Advances like hydroponics and aeroponics have revolutionized growing systems.

FIGURE 78 PREHISTORIC CAVE ART
FIGURE 79 NEOLITHIC AGRICULTURE
FIGURE 80 MESOPOTAMIAN FARMING
FIGURE 81 ANCIENT ROMAN FARMING
FIGURE 82 MEDIEVAL LIFE
FIGURE 83 CHARLES JEFFREY TRACTOR
FIGURE 84 MODERN INDUSTRIAL FARM
FIGURE 85 EDITT TOWER, SINGAPORE

VERTICAL FARMING

Vertical farming is a relatively recent form of agriculture. The term, “vertical farming,” was coined by Ph.D professor Dickson D. Despommier in his book The Vertical Farm: Feeding the World in the 21st Century. His background in parasitology and environmental science drove his desire to change the way we grow food. He asked questions like, “what will the world be like in 2050?” and used his experience to dream up a system for food sustainability.

Using NYC as a model, he calculated how much food could be grown on all the rooftops in the city. Even then, only 2% of the population would be accounted for. He began to wonder “why plants couldn’t live on multiple levels, as human beings do.” And with that, the idea of vertical farming was born.

Despommier began to teach his students his ideas. He gave talks and wrote books about vertical farming and the good it could do for the environment. When his first book was published in 2010, there were no functioning vertical farms. By 2011, several had been built in England, Holland, Japan and Korea. Agriculture has been invented for thousands of years, and was practiced the same way right up to modern times. This new term, vertical farming, armed with alternative strategies and new technology will revolutionize our world.
In the USA today, vertical farms of all sizes function in Brooklyn, Queens, Chicago, Detroit, and Seattle, with more developing every year. The most population crop is baby salad greens, which at premium price, make the operation profitable. Once vertical farm technology has progressed enough, other crops will be adapted for indoor growth (Frazier, 2017).

Relocated Roots aims to build on the work of its vertical farming predecessors. It doesn’t necessarily reintroduce or reinvent the concepts and systems of vertical farming, but it does intend to utilize these modern farming techniques in a *socially-driven community design*. It will connect the commercial farming enterprise with the greater good of supporting a community. Relocated Roots will use the successful elements of other urban agricultural facilities to inform its design, but it will reinterpret the poetics of the facility in order to educate and unify a community. Relocated Roots will relate to similar projects throughout history in pragmatic ways: systems, scale and materiality. But it will build on the work of its predecessors in poetic ways: by emphasizing community, wellness and social activism.

VERTICAL FARMING | FIGURE 86

The historical context of agriculture is also its social context. Agriculture is why society developed. The ability to grow and control our food source allowed mankind to significantly reduce nomadic tendencies and establish permanent homes. Having settlements and reliable food sources meant our ancestors had additional time to spend developing culture and societies. With centuries of technological advances, we have become less and less involved in our food production. There is a social trend to purchase food at a grocery store from a faceless farmer hundreds of miles away. Relocated Roots recognizes the disconnection between us and our food source. It senses the longing of city dwellers to have a relationship with nature, and it believes that an urban farming facility could address both of these trends in an original way. It relates to social trends of stylish city living with its site selection and it shatters the barrier between people and farming by uniting the two right in the community.

SITE ANALYSIS

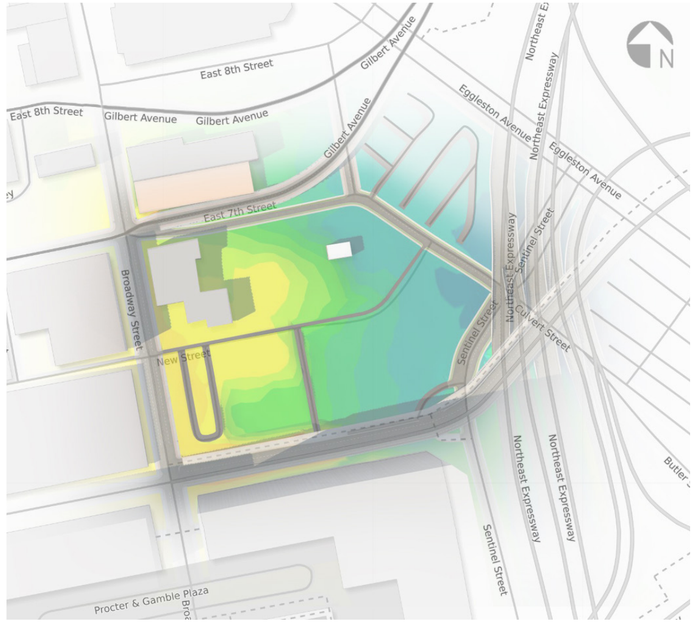
407 NEW ST, CINCINNATI, OHIO

407 NEW STREET BASE MAP | FIGURE 87

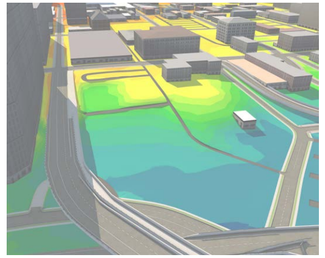
SITE EXTENTS | FIGURE 88

The site is comprised of many individual parcels combined into one 53,000 sf plat. The southern half exists as an at-grade parking lot, whereas the northern half is a two-story daycare. The blocks will be unified in the design of Relocated Roots and the access road between may be incorporated into the project. The project may also attempt to recover some of the lost parking in an additional structure or at grade parking.

TYPOGRAPHY



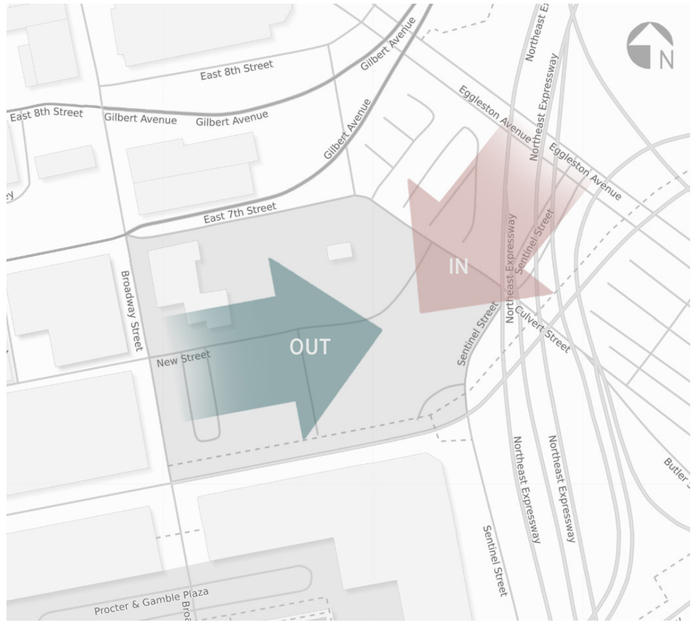
SITE CONTOURS COLORED | FIGURE 89



SITE CONTOURS | FIGURE 90

The site slopes down to the east in order to allow the interstate to pass over it unobstructed. This creates a change in elevation between the west and east ends of the design. The hill created will impact water drainage, grading and building positioning. The highest concentration of design massing will be in the middle of the slope in order to avoid both the pools of cold air at the bottom and the high winds at the top.

VIEWS



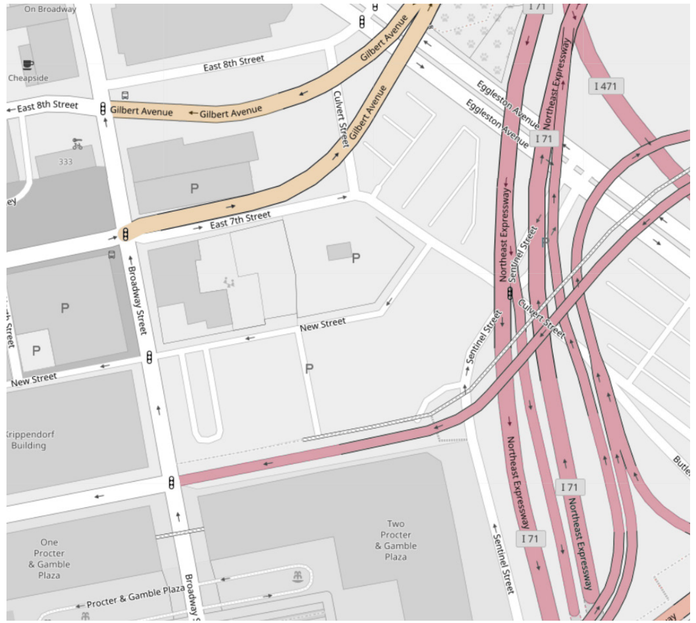
SITE VIEWS | FIGURE 91

The site exists on a hill. The upper or higher portion of the site sits to the west where the lower sinks below the interstate. This change in elevation creates opportunities for views into the site from the highway, and from the site to the hills.

Into the site:
The views into the site are the most important opportunity for Relocated Roots. The design is rooted in social impact, and by aligning itself with a major route for commuters, it maxmizes its exposure to the community. A design mass that is visually compelling from this angle will significantly impact its overall success.

From the site:
The design will sit atop the hill on the west side to maximize views to the east where there is a beautiful residential neighborhood.

CIRCULATION



SITE CIRCULATION | FIGURE 92

Bounding the site on all four sides are means of vehicular traffic. Multiple interstates line the east of the site, and an exit ramp unloads directly to the south. Gilbert Avenue, which serves as an on/off ramp for Route 22 also borders the north of the sight. Additionally, the site is utilized solely by vehicles as it currently serves as a destination for vehicles to park. There are no pedestrian paths or destinations for a pedestrian to interact with on the site. There are several bus stops to the north and south of the site to accomodate public transportation. These stops are easily accessible and visible for passerbys to utilize if needed. Connecting the two Proctor & Gamble buildings, however, is a skywalk. The site lacks an element for pedestrians. The design of Relocated Roots will attempt to provide options for people to interact, as well as a nice place to wait for the bus.

WIND

SITE WIND | FIGURE 93

Winter Winds:
The design will place buffer spaces that have lower temperature requirements along the southwest of the building: closets, storage rooms, stairs, etc. The design will minimize openings facing the southwest as well, to reduce cold air infiltration.

Summer Winds:
The outdoor courtyard will be placed on the southwest of the design in order to capture the summer winds. Because Cincinnati has such humid summers, maximizing the natural ventilation through the space will be important to regulate the humidity. If the design incorporates shading devices, they will be louvered instead of solid, to prevent trapping hot air against the windows. Wind velocity increases with height above the ground, therefore, the main occupied spaces will be on the first floor.

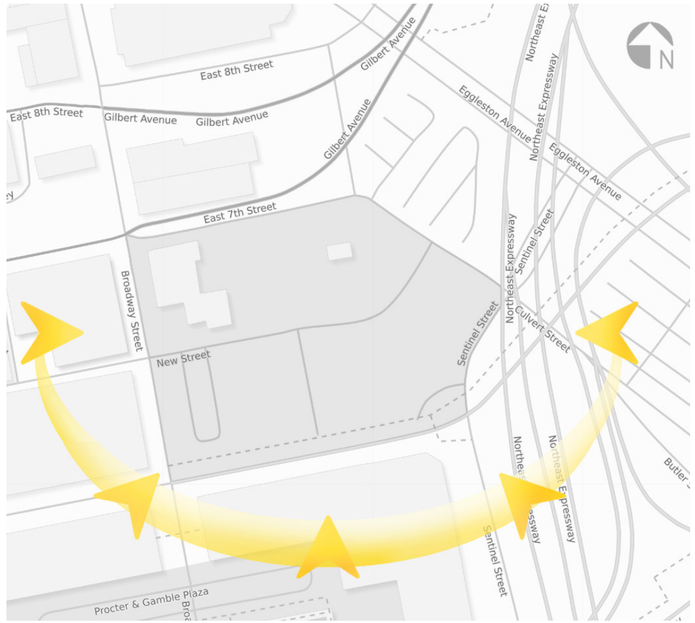
VEGETATION

SITE VEGETATION | FIGURE 94

The area surrounding 407 New Street has a limited amount of vegetation, mostly in the form of street lined sidewalks and as-needed landscaping. The two highest concentrations of vegetation exist directly on the site, and just to the southeast. The first is in support of the existing facility, a daycare. The kids use this playground during their outdoor activity time. The second is landscaping surrounding the highways. The city attempts to dress up the views as commuters travel.

There are some strategies for vegetation that would apply to this design. Because of Cincinnati's winds, the design will use evergreen vegetation to create windbreaks on the ground plane. It will also avoid trees directly on the south side of the building to allow for sunlight in the winter. The design will attempt to add vegetation to the city as well.

SUN STUDIES

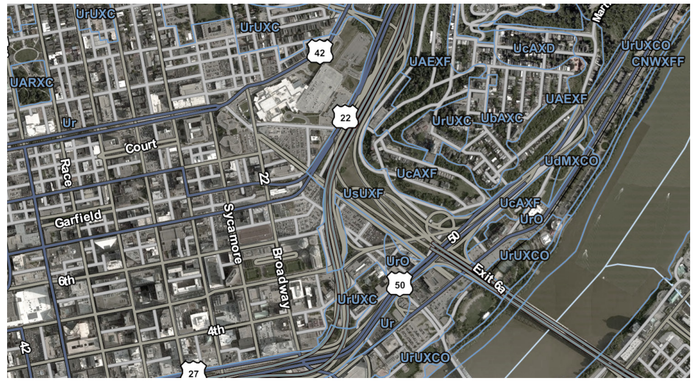


SITE SUN | FIGURE 95

Solar orientation is an important consideration in the design of Relocated Roots. The site's longest axis aligns east to west, which allows for plenty of sunshine for the plants, but also creates challenges for over heating. Therefore, the design will place spaces that benefit from solar heating along the south wall and align spaces where people are the primary occupant along the north and east walls. The south facade will utilize low solar heat gain glazing to minimize some of the summer sun, but the protection created by vegetation will also be incorporated into the landscaping.

The public plaza will also be located on the south of the building in order to maximize the vegetation. This exterior space could benefit from a patio or pergola design that would also create shade in the summertime, but allow sunlight in the winter.

SOILS



Map Unit	Complex	Type of Soil	Percent Slope	Flooded?
CNWXFF	Chagrin-Nelse-Wheeling		2 to 75	Frequently
UAEXF	Alfic Udarents-Eden		25 to 60	
UARXC	Alfic Udarents Martinsville		0 to 12	
UbAXC	Alfic Udarents	loamy substratum over bedrock	0 to 12	
UcAXD	Alfic Udarents	clayey substratum over bedrock	12 to 25	
UcAXF	Alfic Udarents	clayey substratum over bedrock	25 to 60	
UdMXCO	Mollic Udarents	loamy substratum over bedrock	0 to 12	Occasionally
Ur	-		-	
UrO	-		0 to 12	Occasionally
UrUXC	Udorthents complex		0 to 12	
UrUXCO	Udorthents complex		0 to 12	Occasionally
UsUXF	Udorthents complex		0 to 50	

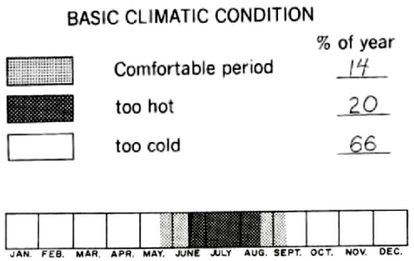
SITE SOILS | FIGURE 96

The soil report was generated from the USDA Natural Resources Conservation Service. The survey is broad and covers regional area surrounding the site instead of the immediate site.

Because of the Ohio River, much of the eastern soils are "clayey" and "loamy," where loamy is a sandy, silty soil mixture. This area is considered the riverbank and is prone to occasional flooding. Further inland is a collection of "Urban Land" soils. These include both paved and unpaved sites. The most variation occurs in the residential neighborhood to the north east of the thesis site.

Several soil samples are written as "over bedrock," which means the soil can support heavier and more robust designs due to its solid foundation. This is important for Relocated Roots as it is a structurally intense design.

CLIMATE



According to Heating, Cooling, Lighting: Sustainable Design Methods for Architects by Norbert Lechner, Cincinnati is located within Climate Region 3. Winters are somewhat milder than othe regions in the Midwest, but winter winds are still a significant concern. There is potential for solar energy because the sun shines more than 40% of the daylight hours. Summers are hot and humid. Precipitation is fairly uniform throughout the year, falling about 39 in (Lechner 2015). According to The National Weather Service, Cincinnati receives 9 inches of snowfall per year during the snowy period of the year (NWSC 2017).

Design Strategies

High Priority

- 1st Keep heat in and cold temperatures out in the winter
- 2nd Protect from the cold winter winds
- 3rd Let the winter sun in

Lower Priority

- 4th Keep hot temperatures out during the summer
- 5th Protect from the summer sun
- 6th Use natural ventilation for summer cooling

WINTER IN CINCINNATI | FIGURE 97

With the availability of winter sunshine, a design with plenty of glazing will benefit from the solar heat gain. Because Cincinnati exists in milder climate zone than other Midwestern regions, winters are more moderate. Summers, however, are hot and humid and a design would benefit from winds from the south west. Winter winds are very cold , so a vegetation buffer may help break or deflect some of the wind. Cincinnati also receives a moderate amount of snow. In 2017, the city received almost 9 inches. Due to this, Relocated Roots should utilize a sloped roof to reduce the effects of snow loads. To battle humidity, the design will avoid fountains and pools in the public plaza.

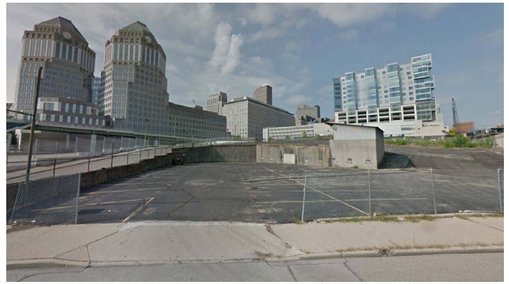
SUMMER IN CINCINNATI | FIGURE 98

SITE CHARACTER

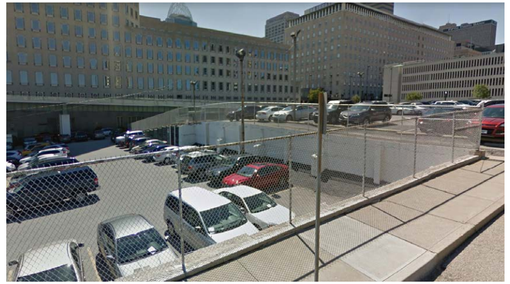
407 New Street is an underutilized site. It has the appearance of being run down and decrepit, which in a vibrant growing city, is a waste of its possibilities. The site is only five blocks from the Ohio River, but this concrete parking lot might as well exist anywhere in the US.

Its overall character appears lifeless and stagnant. The overwhelming amount of concrete is bad for the environment and shows the lack of thoughtful design. The site has no spirit and its clear that its being neglected. Weeds and litter are scattered carelessly throughout the site and chain link fences border nearly all the retaining walls. The site is hard, cold, and sends a message of “keep out!” and “move along quickly.”

While the existing site is dismal, there is a lot of potential for revitalization. The views to and from the site are spectacular. The sun shines bright throughout the year and its proximity to the Proctor & Gamble Headquarters means there will be a consistent stream of passersby, especially in nice weather. The community would benefit from a redesign of this site because its current state is so lacking in life and activity. A community-driven vertical farm would rejuvenate this space and enliven its spirit.

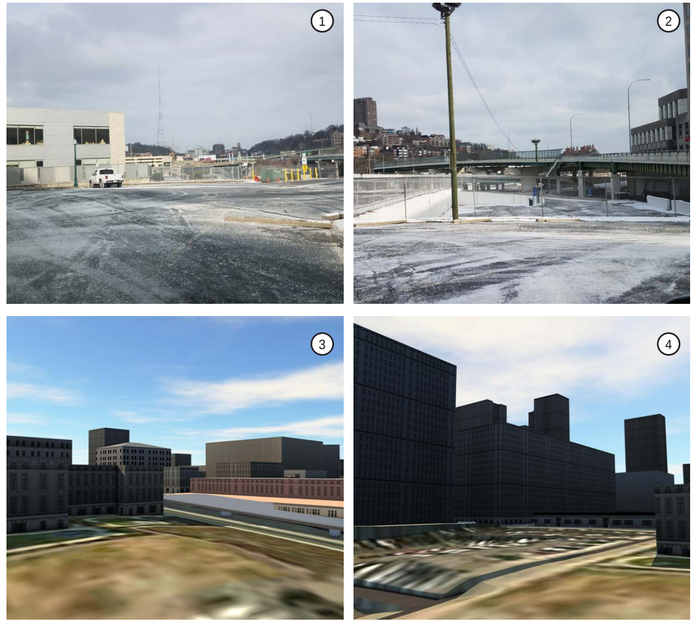


407 NEW STREET, LOOKING WEST | FIGURE 99



407 NEW STREET, LOOKING SOUTH | FIGURE 100

SITE RECONNAISSANCE



VIEW OF THE FOUR CORNERS | FIGURE 101

SITE CORNERS | FIGURE 102

The photogrid to the left depicts the views to the four corners of the site. The most compelling views are #1 and #2, which have lush trees and a beautiful view of the horizon. Views #3 and #4 are towards the city and capture the dramatic skyline and bustling life. The afternoon sun casts many shadows within the city, but the site itself receives plenty of sunshine. Over winter break, I am conducting an official site visit to Cincinnati.

PERFORMANCE CRITERIA

THERMAL PERFORMANCE

The first criteria to evaluate the project will be by its thermal performance. The interior temperatures, air velocities and humidities of each space will be measured and compared against optimal standards for assessment.

Throughout the design process, Autodesk Computational Fluid Dynamics (CFD) will be used to simulate the building's performance in specific conditions. At the conclusion of the project, a final set of simulations will be rendered in order to judge the final design. The final results of the CFD analysis will be transformed into visualization tools for analysis: graphs, charts, and thermal maps. This data will lead to conclusions about the success of the building performance in terms of massing, ventilation, solar orientation and materiality. This performance criteria is intended to test whether the final design reacts appropriately to various conditions, both hot and cold. To evaluate properly, a comfort index will serve as the optimal range, and the design's simulation will be evaluated at specific places using that metric. Any building clad entirely in glass is subject to intense thermal variability and the urban context creates an added level of complexity. Judging this design by its thermal performance is key method of evaluation because it will prove the feasibility of this typology in both scale and plant comfort.

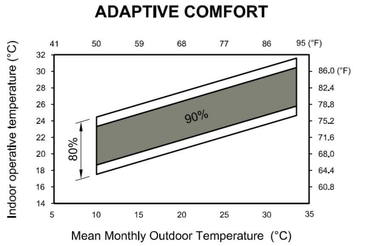
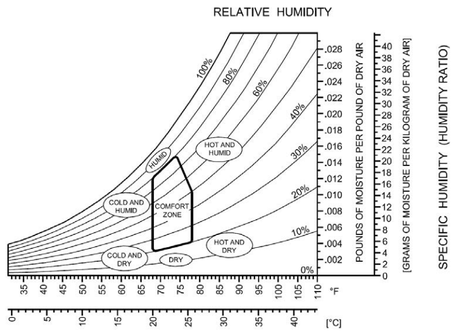


Figure 4.10 Under certain circumstances, people can be comfortable in conditions that fall outside the traditional comfort zone. In naturally ventilated buildings and where occupants have some control over their environment, the adaptive comfort zone increases along with the outdoor temperature. Operative temperature includes both air temperature and MRT.



THERMAL COMFORT ZONES | FIGURE 103

TOTAL FOOD PRODUCTION

The second criteria to evaluate the project will be by the amount of food produced by the design, in reference to the amount of space is required to grow it. The total food production will be measured in pounds, tons, or heads of leafy greens. The space required to grow it will be measured in square feet or acres.

In order to calculate how much food can be grown within the design, each floor plan will need to be fitted with an actual layout of growing trays. The total food production will be based on how many trays fit into the design multiplied by how much food each can produce. By placing growing tray products with specifications, the design will create an accurate measurement of the total food production. In addition to calculating how much food the design can produce, other precedent vertical farms will need to be researched in order to find an appropriate goal. Analyzing existing vertical farms to find a realistic production number is important for this criteria. By comparing and contrasting my crop production performance with other urban farms', I can evaluate whether the facility accomplishes its goal: – to grow more crops in more efficient space. And by inventoring other vertical farms' production, I can assess whether the facility sets a new standard for growing.

VERTICAL PLANTER | FIGURE 104

SPACE ALLOCATION

GOTHAM GREENS GREENHOUSES | FIGURE 105

Company: Gotham Greens
Year: 2011
Location: Greenpoint, Brooklyn

Square Footage: 15,000
Production: 100,000 lbs
Type: Rooftop Greenhouse

Unique Attributes:
First commercial scale greenhouse of its kind in the USA

Company: Gotham Greens
Year: 2013
Location: Gowanus, Brooklyn

Square Footage: 20,000
Production: 200,000 lbs
Type: Rooftop Greenhouse

Unique Attributes:
Fully integrated into the Whole Foods Supermarket below

Company: Gotham Greens
Year: 2015
Location: Hollis, Queens

Square Footage: 60,000
Production: 5 million heads / 500 tons / 900,000 lbs
Type: Rooftop Greenhouse

Unique Attributes:
Incorporates hydroponic technology

Company: Gotham Greens
Year: 2015
Location: Pullman, Chicago

Square Footage: 75,000
Production: 10 million heads of leafy greens and herbs
Type: Rooftop Greenhouse

Unique Attributes:
LEED Platinum Certified

Name	Small (sqft)	Average (sqft)	Large (sqft)	Percentage
Lobby	900	2,500	10,000	5%
Offices	900	2,500	10,000	5%
Mechanical Space	2,700	7,500	30,000	15%
Restaurant	1,260	3,500	14,000	7%
Exterior Courtyard	Site	Site	Site	0%
Classroom / Educational	1,440	4,000	16,000	8%
Greenhouse 1	2,700	7,500	30,000	15%
Greenhouse 2	2,700	7,500	30,000	15%
Greenhouse 3	2,700	7,500	30,000	15%
Greenhouse 4	2,700	7,500	30,000	15%
Total	18,000	50,000	200,000	100%

ALLOCATION CHART | FIGURE 106

18,000 sqft:		
4 Floors	=	4,500
5 Floors	=	3,600
6 Floors	=	3,000
50,000 sqft:		
4 Floors	=	12,500
5 Floors	=	10,000
6 Floors	=	8,333
200,000 sqft:		
4 Floors	=	50,000
5 Floors	=	40,000
6 Floors	=	33,333

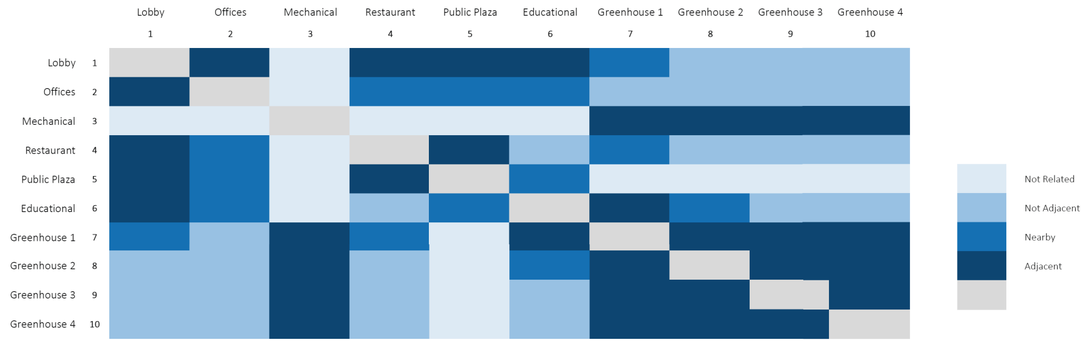
ALLOCATION CHART | FIGURE 107

SPACE ALLOCATION

Relocated Roots will incorporate several spaces in addition to its vertical farming greenhouses. Four projects by Gotham Greens are listed on the opposite page with specific information about each facilities' scale and food production. The client is already capable of generating these numbers, therefore, the above chart proposes the square footage requirements based on the preceding projects. Depending on the scale of the development, small, average, or large, Relocated Roots has some flexiblity in its space allocation due to its design intent for multiple floors.

This chart investigates how the total square footage will translate into a design with multiple stories. If the total site allows for ~53,000 sqft of development, a smaller footprint will be needed to accomodate elements like parking, plaza, and loading.

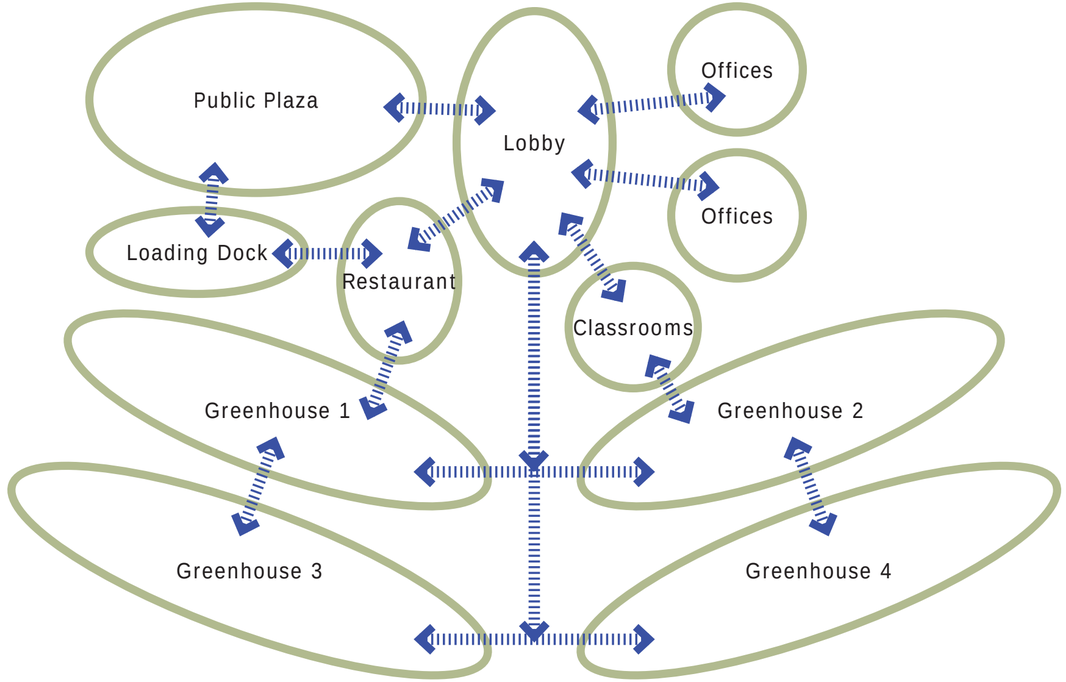
SPACE INTERACTION



INTERACTION MATRIX | FIGURE 108

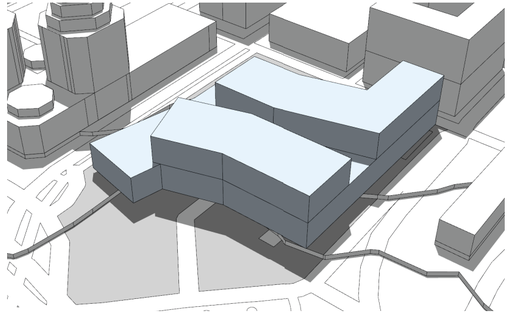
SPACE INTERACTION

The spaces within Relocated Roots will interact primarily through a centralized lobby. This hub will act as the primary location for visitors and users to connect to their destinations. The lobby will provide information and way finding tactics to assist people in finding their intended spaces. The building's other functions will branch off of the lobby in a circular, or radial pattern. Directly to the south will be the building's major element: the greenhouses. Aligning the greenhouses to the south of the lobby provides more opportunities for sunlight throughout the day as well as serving as a buffer between the interstate system and the building patrons' spaces. The restaurant and public plaza will align to the west of the lobby. This will allow for late afternoon sun during the farmer's market events in the summer. The loading dock will need direct interaction with the restaurant and greenhouses and aligns to the west as well.



INTERACTION DIAGRAM | FIGURE 109

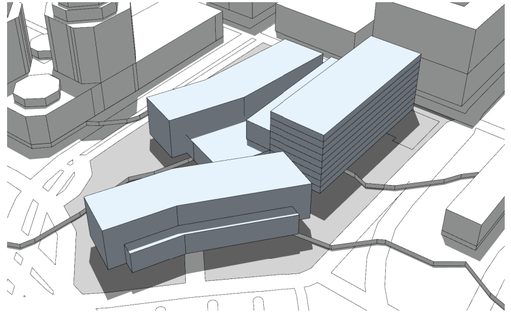
PROCESS DOCUMENTATION



MASSING OPTION | FIGURE 110

MASSING #1
interconnected masses

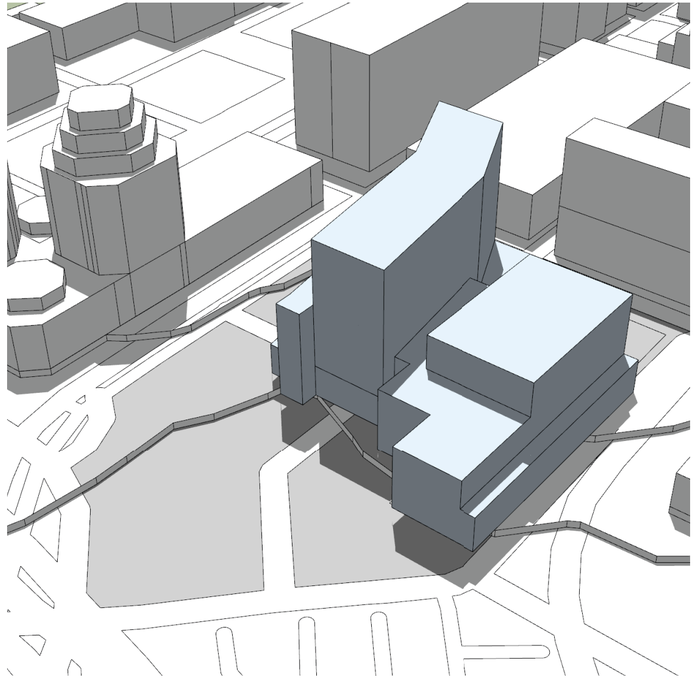
The first massing iterations utilized several design concepts that ultimately guided the final design solution. The first was the concept of interconnected masses. The building program required several functionally different spaces to be connected to allow for easy circulation, educational opportunities and transporation of materials.



MASSING OPTION | FIGURE 111

MASSING #2
consolidating building program

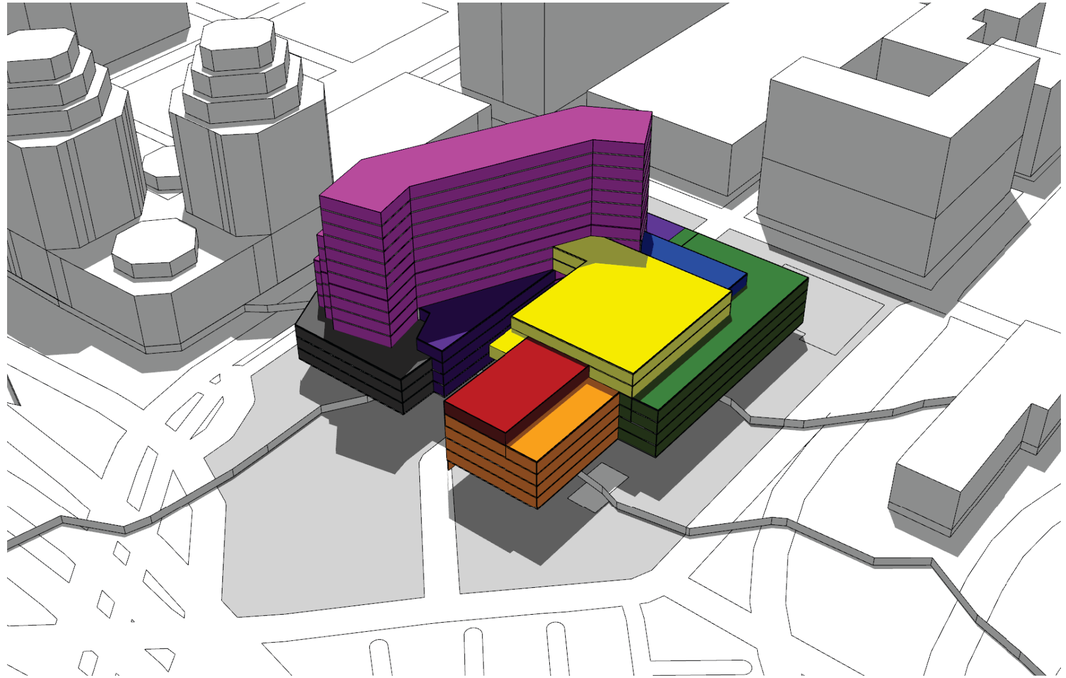
Because the building has significantly different uses throughout the program, it was important to centralize certain spaces to minimize travel paths. The concept of two separate masses was developed early and carried throughout the design process. Having a designated “urban agriculture” facility with separate but connected community-support spaces was an major design driver and ultimately gave considerable influence to the final design solution.



MASSING OPTION | FIGURE 112

MASSING #3
vertical tower

Integrating a vertical tower in relation to the research from the fall semester was also a consideration in the massing interations. Using the research findings' optimal form, site orientation and HVAC layout meant the vertical tower of Relocated Roots would thermally perform better than other designs simulated.



SPACE INTERACTION MASSING OPTION | FIGURE 113

- RESTAURANT
- LEASABLE SPACE
- OFFICES
- PARKING
- CLASSROOMS
- MECHANICAL
- VERTICAL TOWER
- WAREHOUSE

ADDITIONAL BUILDING SPACES

During the site visit to Cincinnati in December 2017, it became clear that additional spaces needed to be included in the building's program. These spaces included the need to maintain the existing site's function as a space for vehicular parking.

The downtown area of Cincinnati relies heavily on parking garages and on-grade lots to allow people to access buildings. More directly related to the site is a headquarters to the south which employs over 1,500 people. If building on the site were to take away from their access, the design would be a failure. Therefore, it became necessary to incorporate a parking garage/structure to fulfill that need.

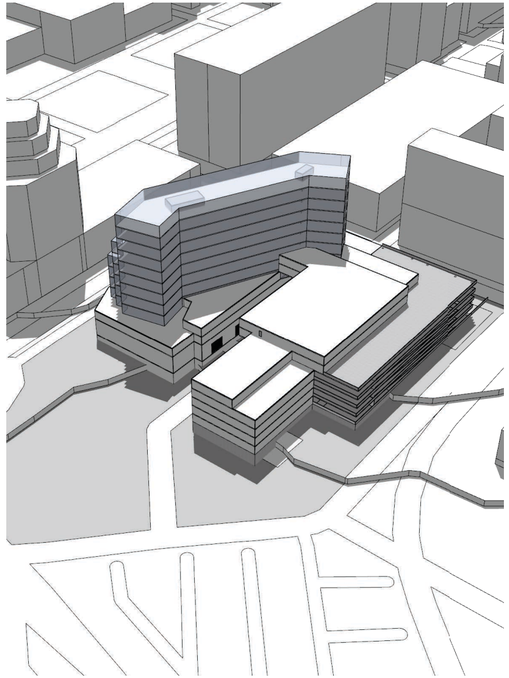
The schematic massing iterations attempted to incorporate these new building elements. It was important to the design to mass according to site considerations like building access and sunlight opportunities.

FIRST MAJOR DESIGN

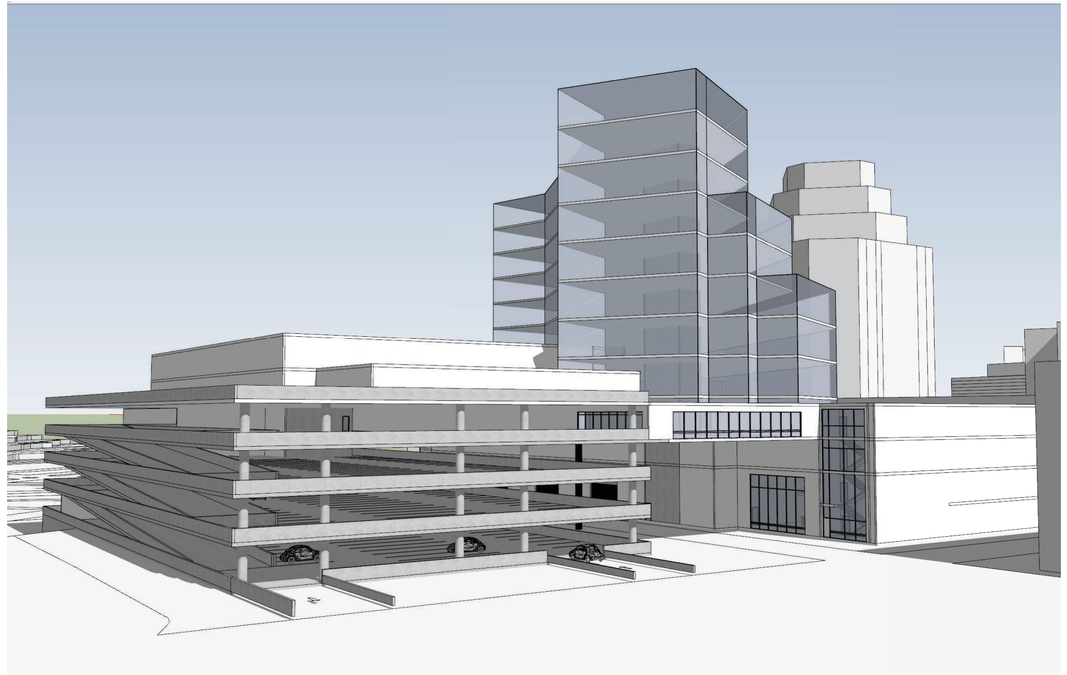
The major design iteration that preceded the final solution set the core concepts that guided the rest of the design process. This first formal iteration did not achieve the balance and visual continuity with the city as it was intended. The first design was built upon the idea of the vertical tower sitting on top of a warehouse podium, adjacent to the community support facility.

Ultimately, this arrangement of building forms did not convey the project goals as comprehensively as desired. Its initial floor planning and massing did not express a connection from the surrounding community to the farming and gardening spaces. The visual appearance was lop-sided and gave too much hierarchy to the vertical tower. There also wasn't enough built up behind the parking structure, which made the garage seem too prominent and control too much of the design's street facade.

Instead, the resulting final design solution built upon the principles founded in this early investigation. It uses the same concepts of interconnection, consolidated functions and balanced vertical tower to communicate a better integration of community into the agriculture facility.

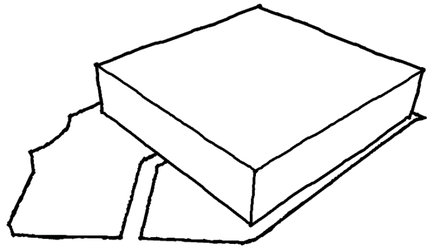


SCHEMATIC DESIGN ITERATION | FIGURE 114

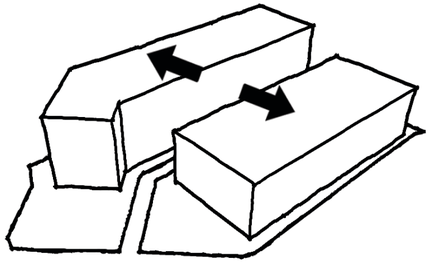


FIRST MAJOR ITERATION PERSPECTIVE | FIGURE 115

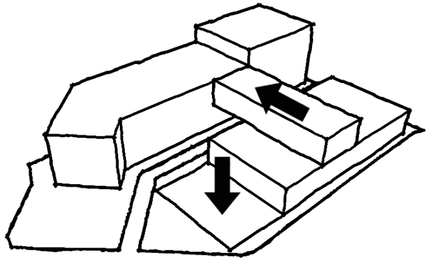
PROJECT SOLUTION DOCUMENTATION



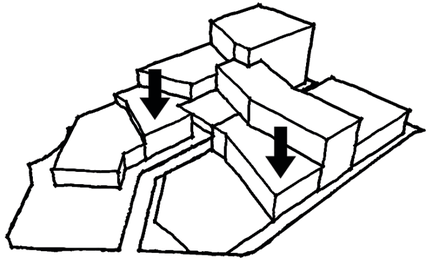
EXTRUSION OF THE BLOCK



SPLIT TO MAINTAIN ACCESS ROAD



CONNECT BUILDINGS AND CREATE OUTDOOR SPACE



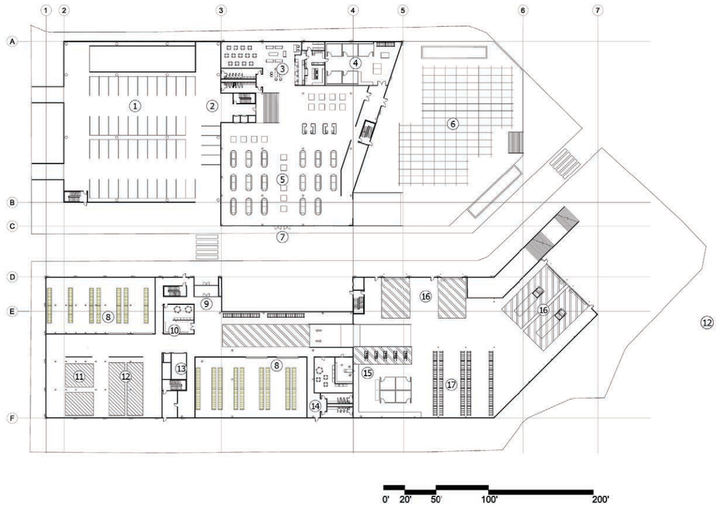
STEP DOWN ROOFS TO MIMIC TOPOGRAPHY

MAJOR DESIGN CONSIDERATIONS | FIGURE 116

FINAL DESIGN PERSPECTIVE | FIGURE 117

FLOOR PLANS

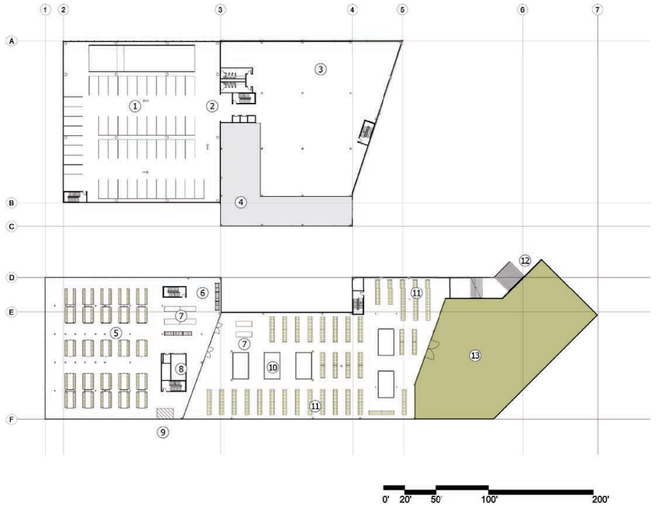
LEVEL ONE



1. Parking Garage (46 Spots)
2. Vehicular Visitors' Main Entry
3. Cafe/Bistro - Open to Public
4. Grocery Store Coolers + Storage
5. Grocery Store
6. Outdoor Patio: Farmer's Market
7. Pedestrian Main Entry
8. Light-Controlled Growing Area
9. Warehouse Employee Main Entry
10. Warehouse Employee Lockers
11. Mechanical Space Including Boiler, Chiller, HVAC
12. Aquaponic Water Treatment Tanks
13. Service Core Including Stair, Service Elevator and Passenger Elevator
14. Warehouse Employee Break Room, Main Office and Restrooms
15. Shipping, Processing and Storage Coolers
16. Delivery, Loading and Unloading
17. Material, Equipment and Pallet Storage

FINAL FLOOR PLAN DRAWING | FIGURE 118

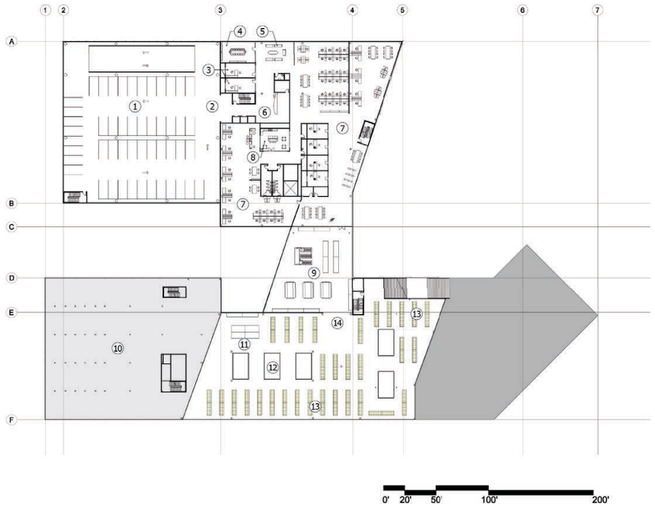
LEVEL TWO



1. Parking Garage (50 Spots)
2. Vehicular Visitors' Main Entry
3. Lease-able Space - Mixed Use
4. Open To Below
5. A-Go-Gro Vertical System (25 Units)
6. Material Storage
7. Planting Tray Processing
8. Service Core Including Stair, Service Elevator and Passenger Elevator
9. Air Handling Unit
10. Light Wells
11. Germination/Growing Space (71 Units)
12. Pedestrian Access To Roof
13. Public Green Roof

FINAL FLOOR PLAN DRAWING | FIGURE 119

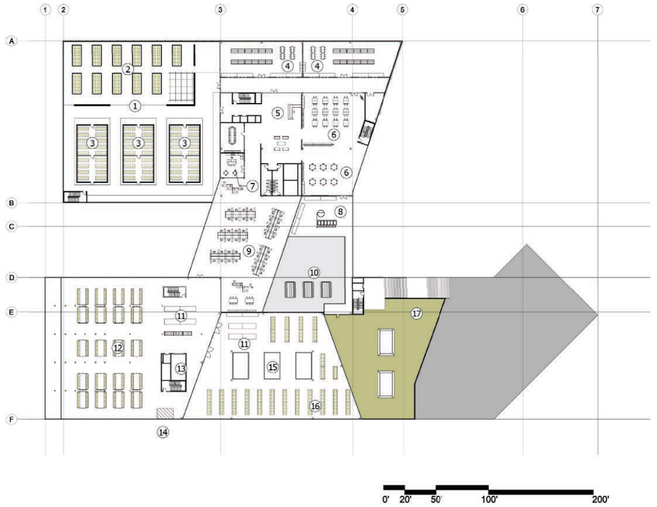
LEVEL THREE



1. Parking Garage (50 Spots)
2. Vehicular Visitors' Main Entry
3. Gotham Greens Administrator Offices
4. Conference Room
5. Waiting Area
6. Reception Desk and Coat Room
7. Gotham Green Open Office, Exec Offices
8. Employee Break Room
9. Research Laboratory
10. Open To Below
11. Plant Tray Processing
12. Light Wells
13. Germination/Growing Space (62 Units)
14. Laboratory Access to Growing Area

FINAL FLOOR PLAN DRAWING | FIGURE 120

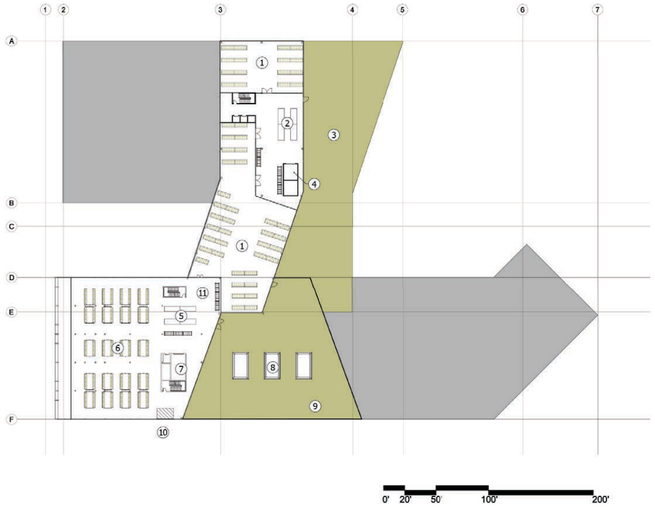
LEVEL FOUR



1. Community Rooftop Gardens
2. Assigned Planters (11 Units)
3. Community Rooftop Greenhouses
4. Hands-On Classroom
5. Urban Harvest Reception
6. Lecture/Traditional Classroom
7. Employee Break Room
8. Educational Mezzanine Level
9. Urban Harvest Open Office
10. Open To Below
11. Planting Tray Processing
12. A-Go-Gro Vertical System (20 Units)
13. Service Core Including Stair, Service Elevator and Passenger Elevator
14. Air Handling Unit
15. Light Wells
16. Germination/Growing Space (35 Units)
17. Public Green Roof

FINAL FLOOR PLAN DRAWING | FIGURE 121

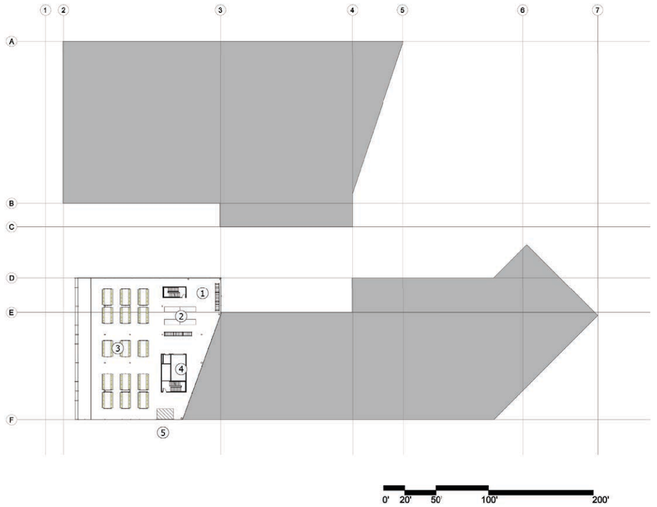
LEVEL FIVE + SIX



1. Germination/Growing Space (52 Total Units)
2. Planting Tray Processing/Workspace
3. Public Green Roof (Level 5)
4. Service Elevator for Levels 5-6
5. Planting Tray Processing
6. A-Go-Gro Vertical System (20 Units)
7. Service Core Including Stair, Service Elevator and Passenger Elevator
8. Light Wells
9. Public Green roof (Level 6)
10. Air Handling Unit
11. Material Storage

FINAL FLOOR PLAN DRAWING | FIGURE 122

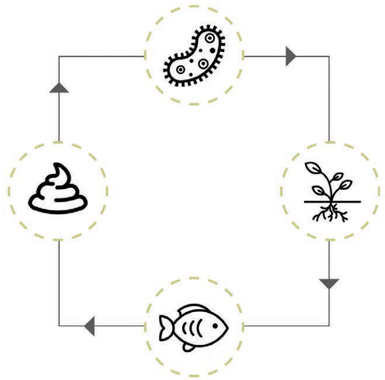
LEVEL EIGHT

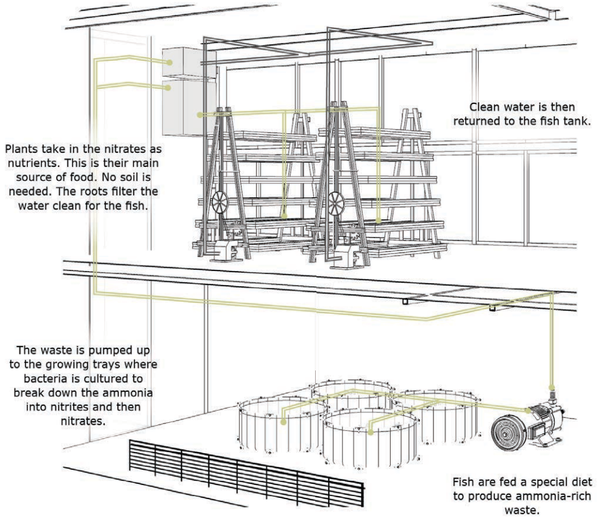


1. Material Storage
2. Planting Tray Processing
3. A-Go-Gro Vertical System (15 Units)
4. Service Core Including Stair, Service Elevator and Passenger Elevator
5. Air Handling Unit

FINAL FLOOR PLAN DRAWING | FIGURE 123

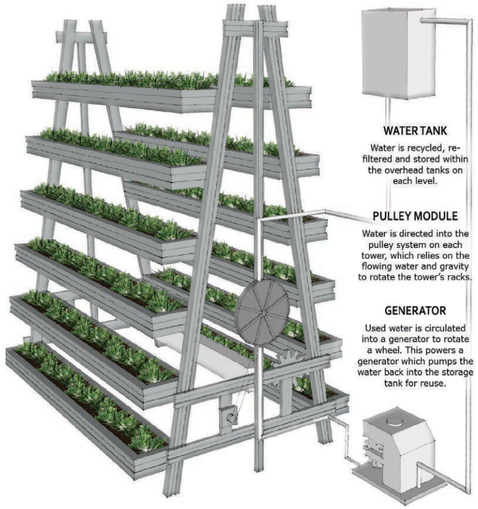
AQUAPONIC GROWING SYSTEM





AQUAPONIC SYSTEM | FIGURE 124

A-GO-GRO VERTICAL SYSTEM



A-GO-GRO VERTICAL TOWER | FIGURE 125

An existing vertical farm called "Sky Green in Singapore provides an excellent precede design of a hydroponic vertical growing syster This A-shaped tower measures up to six mete tall and can grow up to 5x more crops than tl same amount of farmland. This system w selected for Relocated Roots due to its:

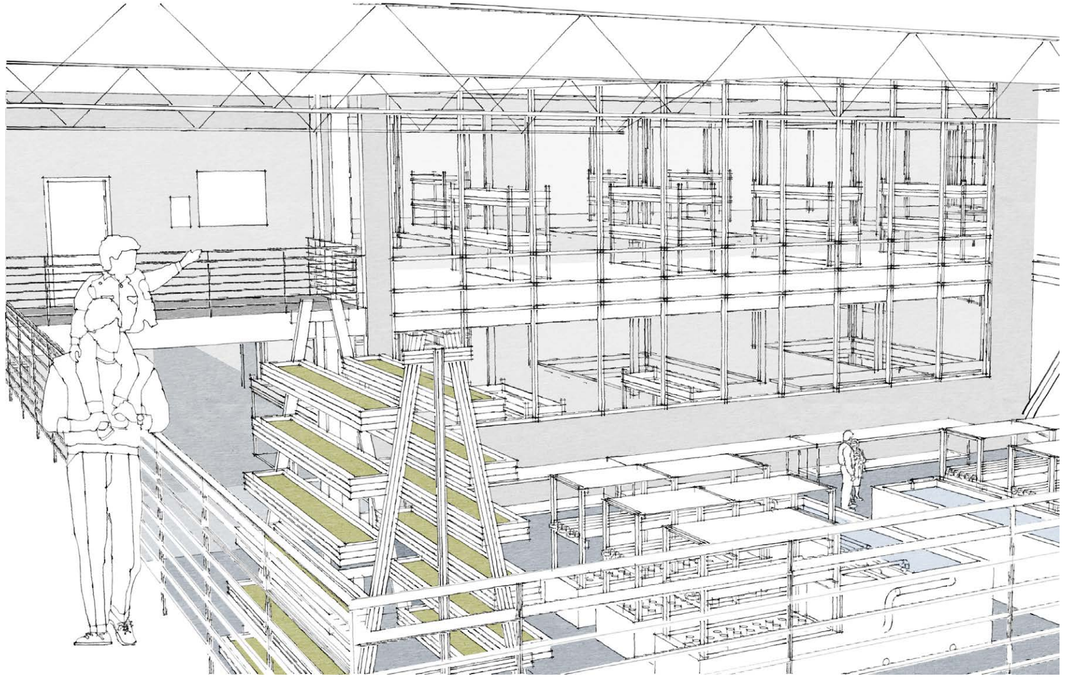
- modularity
- relatively simple installation
- ability to maintain individual units
- flexibility in size and cost
- rotating tray system based on gravity

According to Vertical Harvest, an urban agriculture facility in Wyoming, a traditional farm yields about 20,000 lbs of crop per acre per year. Although crop yield varies, this is a consistent figure.

Vertical farming uses the same footprint, but in a denser way. Vertical Harvest reports producing 100,000 lbs of food for only 1/10th of an acre - a land use of 1/50 of traditional farming.

According to the product specs, the Relocated Roots' growing system located within the multi-story greenhouse can produce the same amount of yield per 100 towers as an entire football field.

With 80 A-Go-Gro tower and 40,000 sf, the Relocated Roots' vertica farm can produce as mu yield as conventional farming, with a 15% decrease in footprint, ar 90% decrease in water



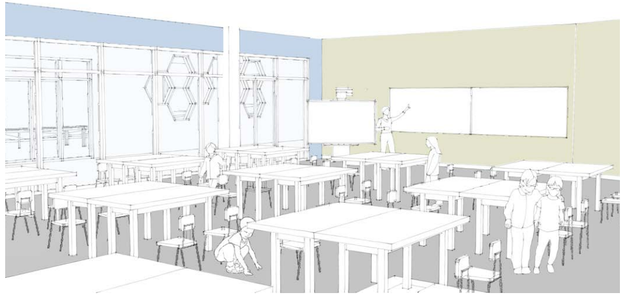
RESEARCH LABORATORY INTERIOR | FIGURE 126

COMMUNITY-FOCUSED

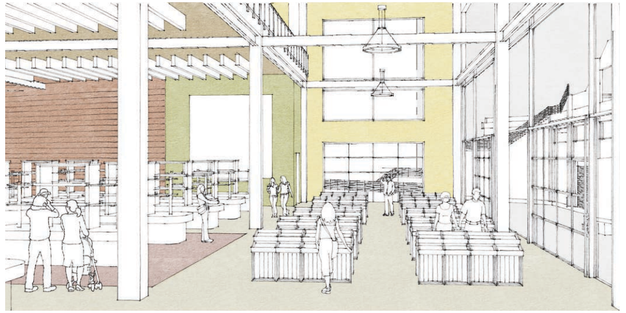
(Top Right) Education + Empowerment
On the fourth floor, there are spaces dedicated to an after-school program for K-12 students. Hands on activities and interactive learning teaches the science of botany, encourages patience and helps students practice responsibility. It also connects the urban youth to nature.

(Bottom Right) Community + Commitment
An organic grocery store is located on the ground floor and opens directly to an outdoor patio which hosts a seasonal farmer's market. This provides the community with fresh greens grown right in the facility. This commitment to locally grown food helps promote holistic wellness and a sense of ownership.

(Left) Innovation + Investment
The Cincinnati location will be the flagship facility for Gotham Greens. Part of the program is designated for plant science and botanical research. It is positioned adjacent to the education spaces to encourage visibility and create familiarity with a STEM discipline.



CLASSROOM INTERIOR | FIGURE 127



GROCERY STORE INTERIOR | FIGURE 128

COMMUNITY GARDENS | FIGURE 129

FARMER'S MARKET | FIGURE 130

IMPACTFUL DESIGN

Not only does Relocated Roots serve the community, but the design itself promotes a message. With a new typology and contemporary construction techniques, the design symbolizes both sustainability and a concern for the well-being of the environment.

There are several types of "community" spaces in the design. The public has access to the rooftop gardens and outdoor farmer's market. These spaces are intended to allow as many city dwellers the opportunity to connect to nature.

The design of the multi-story greenhouse also promotes a message by utilizing new materials and systems while functioning and producing as a successful farming facility. Architecture can promote change through careful and considerate design. By undertaking a struggling site, incorporating principles of sustainability and transforming the space into a place of community and growth, the design of Relocated Roots demonstrates that architecture can become a symbol of the future and act as a vehicle by which social change can travel.

MULTISTORY GREENHOUSE INTERIOR | FIGURE 131

PERFORMANCE ANALYSIS: SITE

SITE DESIGN SOLUTION

One of the biggest opportunities for the design is its site selection. Because community plays such a critical role in the premise, its location in the downtown neighborhood is carefully chosen. The site currently exists as an at-grade parking lot which primarily serves a headquarters building to the south. This parking lot is a void in the dense urban context.

The design incorporations that function into its design solution as to not take away from the community, but rather to maintain this asset and add more to the site. By integrating itself into the existing community, the design is more successful.

To the east of the site is the boundary of the downtown as it is constrained by several interstates. This system of highways provides a motivation for the design to maximize transparency and beauty. This visual exposure to commuters allows the design the opportunity to convey a message of sustainable urban farming simply by its adjacency. Relocated Roots intentionally cascades its roofs towards the interstates in order to create views into the facilities in the hope that by creating a visual connection to the design, commuters will gain familiarity with the typology.

SITE PLAN - NEIGHBORHOOD | FIGURE 132

The Proctor and Gamble headquarters is one block to the south of the site. This office building employs about 1,500 people, and the thesis design capitalizes on this with a parking garage, grocery store, and quick stop restaurant. Additionally, the P&G design has a popular public plaza which adds an additional level of engagement for Relocated Roots' visitors.

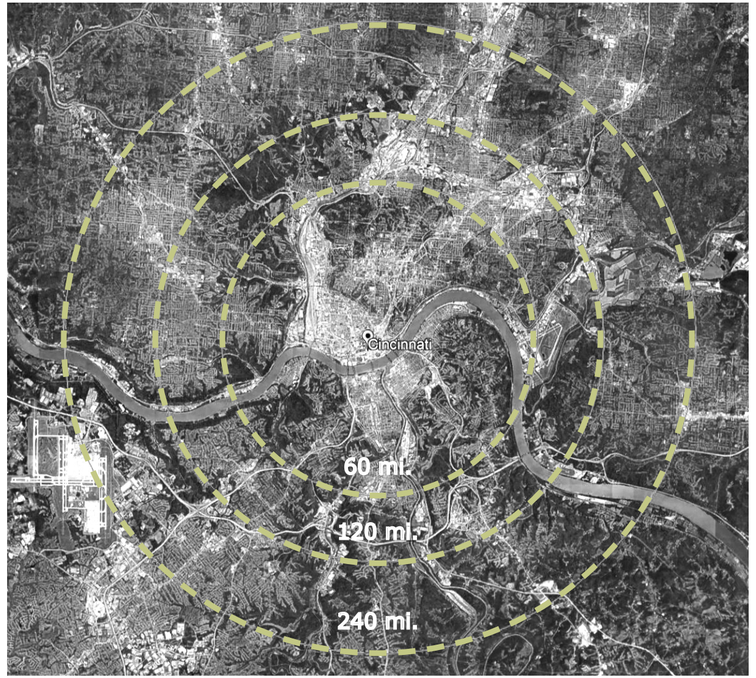
This region of downtown hosts many desirable destinations like historical museums, cultural sites, public parks and restaurants. There's also a theater for music and comedy. These places create incentive for people to visit and thus make the Relocated Roots' site more competitive. By its proximity to these places, the design gains valuable exposure.

Relocated Roots capitalizes on the downtown traffic by providing a destination with food and activity.

SITE PLAN - IMMEDIATE | FIGURE 133

RELOCATED ROOTS WITHIN SITE CONTEXT | FIGURE 134

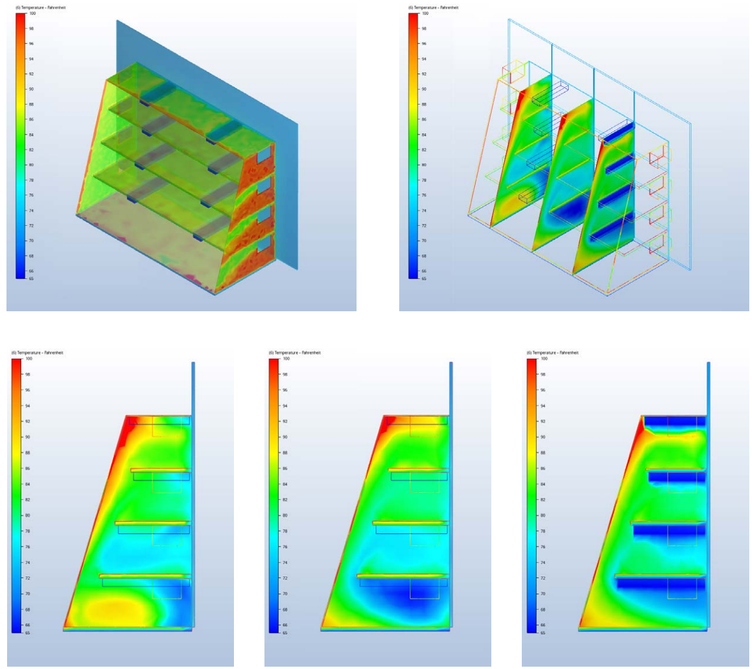
To the north and south of Relocated Roots' site exists entrance and exit ramps for interstate access. This adjacency allows the design to function as a "gateway" into the downtown district. The cascading roofs act as an introduction into the cavernous towers of the downtown, as well as creating visibility and sunlight opportunities into the facility. The hill opposite the highway is home to many Cincinnati residents. Along the highway pictured (left) is a pedestrian trail which connects the two zones.



DISTRIBUTION RANGE | FIGURE 135

The Relocated Roots mission is to provide fresh produce to residents amid the food desert surrounding Cincinnati. A food desert is a region where there is no access to locally grown food and challenging transportation access. To combat this, Relocated Roots follows a distribution network for deliveries to local grocery stores. Relocated Roots could reach communities within a 4 hour radius.

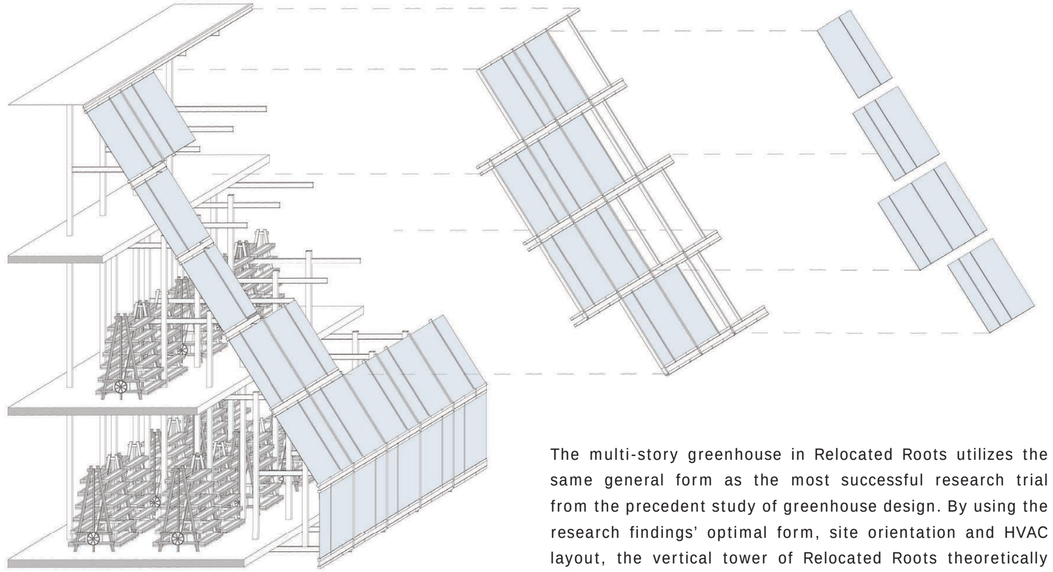
PERFORMANCE ANALYSIS: PRECEDENT RESEARCH



THERMAL SIMULATIONS | FIGURE 136

SIMULATION TRIALS

The second design, the passive solar greenhouse, performs better than the other designs based on its CFD simulation. While its sloped massing leads to a decreased amount of workable floor space, its current thermal evaluation outperforms the others in air circulation and solar heat gain. Its site orientation and massing protect against overexposure to sun and its staggered floors allow for air circulation without limiting floor-by-floor air control.



EXPLODED MULTISTORY GREENHOUSE | FIGURE 137

The multi-story greenhouse in Relocated Roots utilizes the same general form as the most successful research trial from the precedent study of greenhouse design. By using the research findings' optimal form, site orientation and HVAC layout, the vertical tower of Relocated Roots theoretically performs better than other designs simulated. It utilizes a ethylene tetrafluoroethylene (ETFE) panel system to glaze the exterior of the multi-story greenhouse and germination spaces due to its incredibly light weight and simple installation.

PERFORMANCE ANALYSIS: GOALS

LEED PLATINUM CERTIFICATION

Date: 5/7/2018

Y	?	N			
			Credit	Integrative Process	1
28	0	0		**Location and Transportation**	16
16			Credit	LEED for Neighborhood Development Location	16
			Credit	Sensitive Land Protection	1
			Credit	High Priority Site	2
5			Credit	Surrounding Density and Diverse Uses	5
5			Credit	Access to Quality Transit	5
1			Credit	Bicycle Facilities	1
1			Credit	Reduced Parking Footprint	1
			Credit	Green Vehicles	1
10	0	0		**Sustainable Sites**	10
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit	Site Assessment	1
2			Credit	Site Development - Protect or Restore Habitat	2
1			Credit	Open Space	1
3			Credit	Rainwater Management	3
2			Credit	Heat Island Reduction	2
1			Credit	Light Pollution Reduction	1
9	0	0		**Water Efficiency**	11
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
2			Credit	Outdoor Water Use Reduction	2
6			Credit	Indoor Water Use Reduction	6
			Credit	Cooling Tower Water Use	2
1			Credit	Water Metering	1
13	0	0		**Energy and Atmosphere**	33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
			Credit	Enhanced Commissioning	6
9			Credit	Optimize Energy Performance	18
1			Credit	Advanced Energy Metering	1
2			Credit	Demand Response	2
			Credit	Renewable Energy Production	3
			Credit	Enhanced Refrigerant Management	1
1			Credit	Green Power and Carbon Offsets	2
7	0	0		**Materials and Resources**	13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
5			Credit	Building Life-Cycle Impact Reduction	5
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit	Construction and Demolition Waste Management	2
15	0	0		**Indoor Environmental Quality**	16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
			Credit	Construction Indoor Air Quality Management Plan	1
2			Credit	Indoor Air Quality Assessment	2
1			Credit	Thermal Comfort	1
2			Credit	Interior Lighting	2
3			Credit	Daylight	3
1			Credit	Quality Views	1
1			Credit	Acoustic Performance	1
6	0	0		**Innovation**	6
5			Credit	Innovation	5
1			Credit	LEED Accredited Professional	1
0	0	0		**Regional Priority**	4
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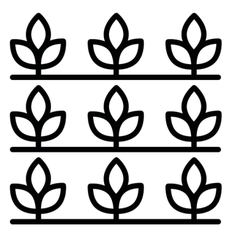
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
			Credit	Regional Priority: Specific Credit	1
88	0	0		**TOTALS** Possible Points:	110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

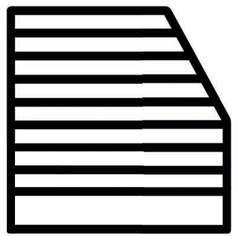
FINAL FLOOR PLAN DRAWING | FIGURE 138

FOOD PRODUCTION

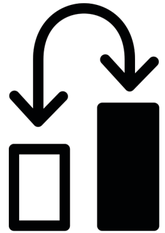
According to Vertical Harvest, an urban agriculture facility in Wyoming, a traditional farm yields about 20,000 lbs of crop per acre per year. Although crop yield varies, this is a consistent figure.



Vertical farming uses the same footprint, but in a denser way. Vertical Harvest reports producing 100,000 lbs of food for only 1/10th of an acre - a land use of 1/50 of traditional farming.



The Relocated Roots' vertical growing system located within the multi-story greenhouse can produce the same amount of yield per 100 towers as an entire football field.

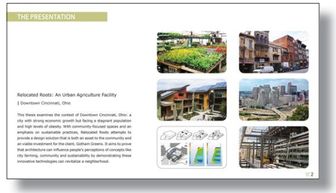


With 80 A-Go-Gro towers and 40,000 sf, the Relocated Roots' vertical farm can produce as much yield as conventional farming, with a 15% decrease in footprint, and 90% decrease in water.

FINAL FLOOR PLAN DRAWING | FIGURE 139

DIGITAL PRESENTATION

1



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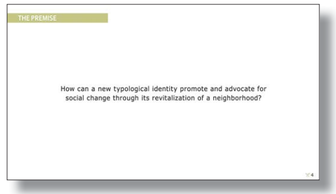

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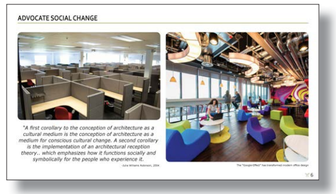

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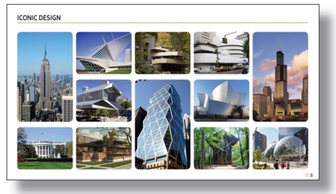

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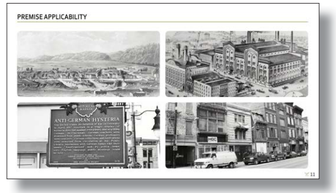

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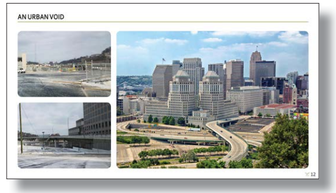

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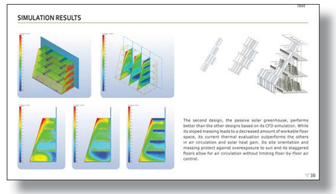

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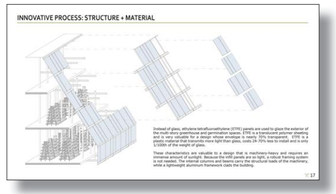

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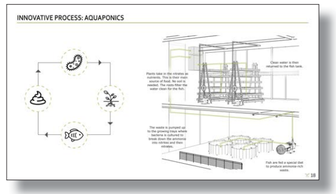

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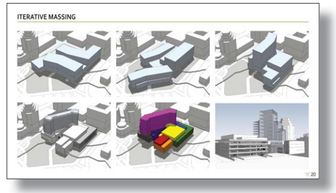

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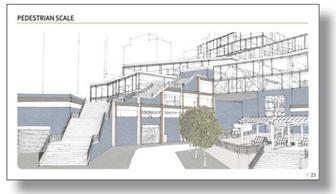

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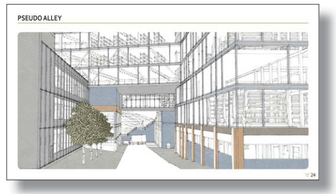

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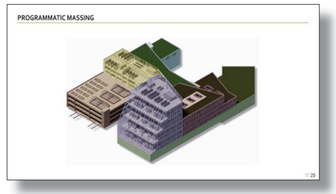

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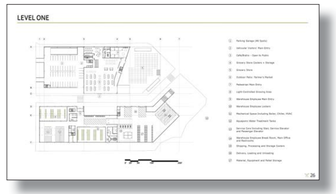

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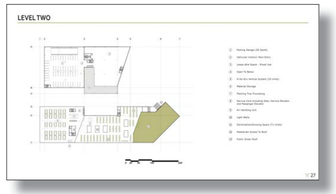

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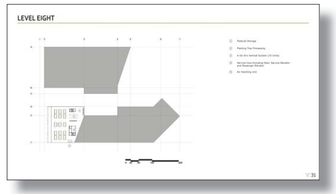

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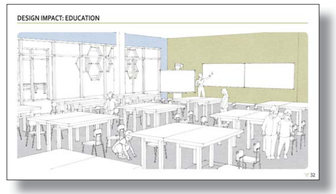

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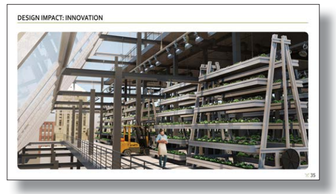

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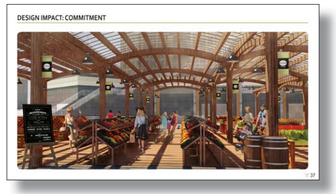

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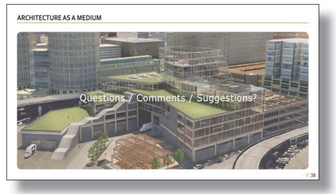

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PROJECT INSTALLATION

PRESENTING AT THESIS EXHIBITION | FIGURE 140

MCKENZIE AWARD FINALISTS | FIGURE 141

FINAL MODEL | FIGURE 142

FINAL EXHIBIT IN FLAKOLL GALLERY | FIGURE 143

APPENDIX: REFERENCE LIST

Journal Articles

Capaldi, C. A., Dopko, R. L., & Zelenski, J. M. (2014). The relationship between nature connectedness and happiness: a meta-analysis. Frontiers in Psychology, 5, 976. Retrieved from http://doi.org/10.3389/fpsyg.2014.00976

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LIST OF IMAGES + FIGURES

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Figure 1	6	chicagotribune.com/news/local/breaking/ct-rooftop-farms-met-20150610-story.html
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Figure 5	14	ignant.com/2015/10/01/stedsans-rooftop-farm-restaurant-copenhagen/
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Figure 17	23	www.outpostjh.com/vertical-harvest-jackson-hole/
Figure 18	24	inhabitat.com/this-vertical-farm-will-provide-wyoming-residents-with-100000lbs-of-fresh-produce
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Figure 31	32	grimshaw.global/projects/via-verde-the-green-way/
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Figure 33	32	grimshaw.global/projects/via-verde-the-green-way/
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figure	page	source
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Figure 82	77	wga.hu/index.html
Figure 83	77	tractors.wikia.com/wiki/Thomas_B._Jeffery_Company
Figure 84	77	motherearthnews.com/homesteading-and-livestock/sustainable-farming/healthy-food-amendment
Figure 85	77	hubpages.com/food/Vertical-Farming-Feeding-our-future
Figure 86	79	cdn.modernfarmer.com/wp-content/uploads/2015/01/plantplant.jpg
Figure 87	80	Custom Graphic, Base from openstreetmap.org
Figure 88	80	Custom Graphic, Base from openstreetmap.org
Figure 89	81	Custom Graphic, Base from openstreetmap.org
Figure 90	81	Custom Graphic, Base from openstreetmap.org
Figure 91	82	Custom Graphic, Base from openstreetmap.org
Figure 92	83	Custom Graphic, Base from openstreetmap.org
Figure 93	84	Custom Graphic, Base from openstreetmap.org
Figure 94	85	Custom Graphic, Base from openstreetmap.org
Figure 95	86	Custom Graphic, Base from openstreetmap.org
Figure 96	87	websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Figure 97	89	www.flickr.com/photos/thaddfiala/5382378185/
Figure 98	89	www.flickr.com/photos/thaddfiala/21660790268/
Figure 99	90	www.maps.google.com/

figure	page	source
Figure 100	90	www.maps.google.com/
Figure 101	91	(1-2) Personal photograph, taken 1/2/18; (3-4) Custom Graphic, Base from Autodesk Infraworks
Figure 102	91	Custom Graphic, Base from openstreetmap.org
Figure 103	92	Heating Cooling Lighting by Nobert Lechner
Figure 104	93	2de5631rzvsy2k87a938eazg-wpengine.netdna-ssl.com/wp-content/uploads/2017/03/zipgrow-hyd
Figure 105	94	gothamgreens.com/our-farms/greenpoint
Figure 106	95	Custom Graphic, Microsoft Excel
Figure 107	95	Custom Graphic, Microsoft Excel
Figure 108	96	Custom Graphic, Microsoft Excel
Figure 109	97	Custom Graphic, Microsoft Excel
Figure 110	98	Custom Graphic, Base from Sketchup
Figure 111	98	Custom Graphic, Base from Sketchup
Figure 112	99	Custom Graphic, Base from Sketchup
Figure 113	100	Custom Graphic, Base from Sketchup
Figure 114	102	Custom Graphic, Base from Sketchup
Figure 115	103	Custom Graphic, Base from Sketchup
Figure 116	104	Custom Graphic, Base from Sketchup
Figure 117	105	Custom Graphic, Rendered in Vray
Figure 118	106	Custom Graphic, Base from Autodesk Revit
Figure 119	107	Custom Graphic, Base from Autodesk Revit
Figure 120	108	Custom Graphic, Base from Autodesk Revit
Figure 121	109	Custom Graphic, Base from Autodesk Revit
Figure 122	110	Custom Graphic, Base from Autodesk Revit
Figure 123	111	Custom Graphic, Base from Autodesk Revit
Figure 124	112	Custom Graphic, Base from Sketchup; Icons from thenounproject.com

figure	page	source
Figure 125	113	Custom Graphic, Base from Sketchup; Icons from thenounoproject.com
Figure 126	114	Custom Graphic, Base from Sketchup
Figure 127	115	Custom Graphic, Base from Sketchup
Figure 128	115	Custom Graphic, Base from Sketchup
Figure 129	116	Custom Graphic, Rendered in Vray
Figure 130	116	Custom Graphic, Rendered in Vray
Figure 131	117	Custom Graphic, Rendered in Vray
Figure 132	118	Custom Graphic, Created in Illustrator; Base from cadmapper.com
Figure 133	119	Custom Graphic, Created in Illustrator; Base from cadmapper.com
Figure 134	120	Custom Graphic, Base from https://www.gettyimages.com/photos/cincinnati
Figure 135	121	Custom Graphic, Base from Google Earth
Figure 136	122	Custom Graphic, Base from Autodesk CFD
Figure 137	123	Custom Graphic, Base from Sketchup
Figure 138	124	signaturesustainability.com/wpinhere/wp-content/uploads/2016/06/Checklist.png
Figure 139	125	Icons from thenounproject.com
Figure 140	130	Photograph, Taken 5/4/2018 by Bakr Aly Ahmed
Figure 141	131	Photograph, Taken 5/4/2018 by Bakr Aly Ahmed
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APPENDIX: STUDIO EXPERIENCE

Joan Vorderbruggen

ARCH 271:
Architectural Design I

- Teahouse
- Minneapolis Rowhouse

Adam Beck

ARCH 371:
Architectural Design III

- Red River Arts Center
- 262 Bowery

Darryl Booker

ARCH 272:
Architectural Design II

- Montessori School
- Pritzker Birdhouse
- Tiny House

David Crutchfield

ARCH 372:
Architectural Design IV

- Midwest Steel Institute
- Miami Breeze Hotel

Bakr Aly Ahmed

ARCH 471:
Architectural Design V

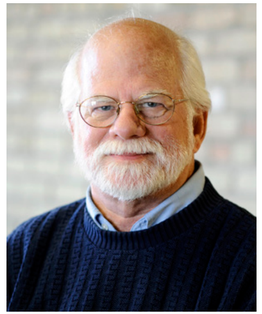
- Comprehensive Design High Rise

Ganapathy Mahalingam

ARCH 771: Advanced Architectural Design

ARCH 772:
Design Thesis

- Research Studio
- Thesis



Don Faulkner

ARCH 472:
Architectural Design VI

- 3D Modeling/Building Urban Design

APPENDIX: PERSONAL

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